JPRS-UAC-89-006
16 AUGUST 1989

FOREIGN
BROADCAST
INFORMATION
SERVICE

JPRS Report

Soviet Union

AVIATION & COSMONAUTICS

No 12, December 1988

Soviet Union
AVIATION AND COSMONAUTICS
No 12, December 1988

JPRS-UAC-89-006 CONTENTS 16 August 1989

[The following are translations of selected articles from the Russian-language monthly journal AVIATSIYA I KOSMONAVTIKA published in Moscow. Refer to the table of contents for a listing of any articles not translated.]

AVIATION AND COSMONAUTICS

No 12, December 1988

Pilots Claim Safety Restrictions Hamstring Serious Combat Training Performance

91441150a Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 88 (signed to press 4 Nov 88) pp 1-3

[Article by Mar Avn A. Yefimov, Commander in Chief of the Air Forces: "The Right to Make a Mistake"]

[Text] Our lives are changing rapidly. Sometimes changes are not readily apparent, but they are unquestionably taking place. This is a result of development and deepening of the processes of perestroyka. The dialectics of life are also reflected in the mail received by Air Forces officials.

What was the subject of letters written by military aviation personnel to higher echelons several years back? They were most frequently letters of complaint. Complaints about injustice, lack of housing, available services and amenities, etc, and complaints about shortcomings in combat training facilities and support services.

But then came April 1985, and letters were filled with firm belief not only in the need for radical changes in the entire combat training system but also confidence that the desired results would soon be achieved.

Perestroyka is becoming more extensive from one party decision to the next. The letters are also changing. And today, following the 19th All-Union Party Conference, two principal themes permeate every line of the many letters we receive: specific suggestions on improving combat training of units and subunits and sharp rejection of everything which impedes increasing readiness for combat, holds back increase in professional skills, and undermines flight safety. Many letters are literally filled to the brim with innovativeness, a sense of responsibility, and desire on the part of the letters' authors to shoulder the Air Forces' most difficult problems.

I should like to share some of the thoughts evoked both by letters and by practical efforts to achieve combat readiness, professional expertise, and flight operations safety....

Military aviation personnel critically addresse the question of the correlation between combat skill and flight safety and are frankly upset by the adoption of temporary restrictions and prohibitory regulations pertaining to certain particular types of training.

Let us discuss prohibitory regulations and restrictions in a calm, thoughtful, and professional manner.

Perhaps the most common wish expressed by flight personnel pertains to extending the permitted range of performance and flight configurations allowed in practical combat training. Pilots want very much to fly at extremely low level and at speeds and load factors close to critical. They consider operation to the edge of such performance envelopes to provide them the greatest possibility of success in actual combat. They view existing restrictions as preventing them from achieving full performance capability and solid professionalism, and even as the pursuit of "apparent safety" to the detriment of actual safety. This is harsh criticism of Air Forces higher authorities. What is the actual state of affairs?

Unquestionably flying in a subcritical configuration pertaining to some one parameter is more hazardous than flying in configurations far from the boundary of the crisis phenomenon envelope. But what arguments are presented by the advocates of flying at the outer edge of an aircraft's performance envelope, claiming objective necessity and personal need to master these beckoning regions of aircraft performance?

Many arguments are presented, and they are quite varied. They include the argument of flying at the edge of the risk envelope as the principal alternative when penetrating a formidable air defense system. And they express uncompromising conviction that actual combat will compel them to reject any and all restrictions. Some acknowledge that training sorties of greater complexity are the best method of moral-psychological conditioning of combat pilots. Others state that the potential adversary does not impose any regulations which restrict the freedom of the professional military pilots.

Well, the above-enumerated arguments do contain certain logic. Yes, flying at extremely low level does to a certain degree complicate the combat situation for an air defense system in engaging threat aircraft. Yes, in combat the mission is of primary importance, dictating its own law: accomplish the mission; you do not have the right not to accomplish it! Yes, difficult training sorties mentally and emotionally toughen a pilot. And the potential adversary is endeavoring to gain total mastery of the combat capabilities of his aircraft.

And most of all, it is precisely reference to the benefits of flying at the edge of the performance envelope which forms the ranks of fervent opponents of any restrictions or limitations in flying training sorties. But any one-sidedness is fraught with the possibility of serious error. This is true in our daily lives, it is true in science, and it is equally true in flying. What if we test the strength of the pro arguments with arguments against? Let us consider the matter....

Performance envelope. It seems to me that one must understand as a professional and perceive from a moral and ethical standpoint that there is a well-validated and

logical difference between an aircraft's technical performance capabilities and its reasonable capabilities from the standpoint of tactical acceptability. What determines this discrepancy between the technical and tactical performance envelopes or ranges of aircraft? Essentially there are two factors involved. First of all, there is a sharp decrease in combat maneuverability in configurations close to critical. Second, there is need for a flight capabilities reserve for the probable errors a pilot will make in a combat situation because of being workloaded by solving tactical problems, which are dominant over all other considerations.

Yes, an aircraft is capable of flying close to a critical configuration. But a pilot will be unable to execute a vigorous attack or fire-evasion maneuver. This is the moment of reckoning for substituting a semblance of tactical maneuverability for actual tactical maneuverability: the aircraft still remains airborne, but it is virtually combat-ineffective. And at such moments the pilot is fighting his aircraft rather than the enemy. He is in the power of circumstances to which he cannot respond. He is in the hands of an opponent who has the advantage of possessing an obedient aircraft. The enemy will exploit such an advantage in a professional manner.

Those veteran combat pilots who have found themselves in such a dangerous situation will never forget those few seconds in which they were doomed. It is for this reason that restrictions are adopted, which in fact represent a margin of combat reliability which will not only bring victory but also save the combat pilot's life in battle.

Low level flight. Modern air defense systems have appreciably diminished the effectiveness of very low altitude flight as a method of aircraft passive self-defense. In addition, to fly in the immediate proximity of the ground means to expose oneself to fire not only by "traditional" air defense weapons but also to fire by all types of ground-troops weapons. And this is a considerable additional danger. In addition, obstacles—both natural and man-made—are immediately transformed into a very real threat.

There is reference to the comprehensiveness and "unrestricted nature" of the potential adversary's professional training. The adversary trains for combat, endeavoring to reduce compromise with realism as much as possible during training sorties. This is an incontrovertible fact. But it is absurd to attribute recklessness to him. For this reason there is not a single air force anywhere in the world which does not adopt certain prohibitory regulations and restrictions. And such decisions are carried out to the letter. Such compulsory measures are applied in connection with specific phenomena and events attending flight activities. The rigidity and boundaries of restrictions, the nature and duration of effect of prohibitory regulations are determined not by somebody's good or ill will but rather by the state of practical military aviation activities.

A disturbing but inevitable discrepancy between theory and reality is manifested in restrictions and prohibitory regulations. What this means is that something has not been fully determined, investigated, or resolved, and immediate, extreme decisions must be made in order to prevent the further occurrence of an unexpectedly-appearing dangerous trend.

To be quite frank, for Air Forces authorities any prohibitory regulation is a very difficult decision which tests our responsibility for combat readiness, command competence, and our ability in a difficult situation to make the only correct choice of all possible choices. Finally, to adopt prohibitory measures means finding in oneself the courage, without considering possible suspicions of being excessively conservative, to halt a process which is natural but at the given moment is harmful and dangerous.

Prohibitory regulation and restrictions are emergency decisions. But they are made in order to avoid actual mishaps.

What follows after a prohibitory regulation? What is the fate of temporarily estbalished restrictions?

Air Forces authorities, if not simultaneously with issuing a prohibitory regulation then immediately thereafter, work out a program, grounded on hard, intense analytical effort, to correct or overcome negative phenomena which undermine combat readiness, diminish the level of complexity of flight assignments and, consequently, diminish professional skill and erode away the morale and psychological state of military aviators. Such a program has one aim: to restore or to form a favorable situation for continuous improvement of Air Forces combat power. The main concern after establishing any restriction is to find an effective way to cancel it as rapidly as possible.

But a program is only a program. It must be implemented. And not at main headquarters, not in the directorates, but in the aircrews, flights, and subunits. The depth of understanding of the spirit, idea, and content of prohibitory measures, the conscientiousness and specificity of execution of prescribed regulations, as well as genuine responsibility for combat readiness determines the time required to overcome negative phenomena and, consequently, the duration of effect of restrictions. All this is in the hands of the pilots, including those who do not like prohibitory regulations and who become angry and indignant over restrictions.

But what is being done in some units and subunits to perform the only work which can result in a prohibitory regulation being rescinded, and how is that work being done? Let us turn to the simplest example.

...An air mishap occurred during advanced aerobatic maneuvers. A highly-skilled pilot was unable to handle vigorous execution of a loop. An inquiry was held. This

resulted in a proposal to implement a number of measures aimed at preventing a pilot from getting into such a situation in the future. In particular, the board of inquiry recommended thorough individual evaluation of each pilot's actual state of preparedness for and proficiency in advanced aerobatic maneuvers.

Reports are starting to come in on execution of all prescribed and scheduled measures, that is, in fact stating readiness to continue the normal process of combat training. This means that the temporary restrictions can be lifted. But nevertheless it is better to check in advance to determine whether the program of prescribed measures to eliminate this dangerous trend has been fully carried out. This is dictated by practical experience.

We check into things, and we learn a surprising fact.... It turns out that there are not dozens of unique pilot individualities in the air regiment, but only two to three "types." This is how they responded to the requirement of an individual approach. And there is not a single pilot among them who is not capable of expert-level advanced aerobatic maneuvers. And not one pilot needs therapeutic rest. And not one pilot needs special practice sessions to increase his resistance to high G loads. Nor is there a single commander who needed to consult with specialists in aerodynamics and with aviation psychologists.

There are many other surprising items as well, but they all boil down to a single basic point: a lip-service attitude and irresponsible, superficial implementation of the program in response to the prohibitory regulation, a program which was proposed by he who adopted the prohibitory regulation. After this can the restriction be lifted? And who in the final analysis determines how long prohibitory decisions are to remain in effect? If we face facts and do not manipulate perhaps externally effective but superficial facts. If we do not hide behind self-deception.

One can and, in our opinion, one should formulate the problem as follows: prohibitory regulations and rescinding of such regulations are the result only of joint effrots by command authorities and all personnel. This characterizes the genuine vital activity of the Air Forces. Emotions can lead one all over the place, sometimes a great distance from a difficult and unglamorous task....

Of course there are very many acute issues which arise as a consequence of letters, statements by military aviation personnel, and newspaper articles. And it is impossible even to touch upon every item in a single frank conversation. But there are things which simply cannot tolerate delay or postponement. Very frequently there is discussion about the legitimacy of taking risk during training flights and in the course of tactical air exercises....

But just what is risk? One can discourse about and debate over risk without understanding its substance and nature. I believe that one must realize that risk involves two aspects: a moral-psychological aspect and a military-professional aspect.

As for the former, what is in fact being evaluated is a person's emotional willingness to expose himself to heightened danger in the interests of accomplishing a combat mission. Everything is clear and simple in this regard. Soviet aviators have never been and are not now inferior to anybody in moral-psychological readiness and willingness to go through fire and flood in defense of the homeland.

The military-professional aspect of risk requires a profound understanding of this specific combat phenomenon. Risk is behavior in combat whereby a pilot consciously chooses actions which are other than those dictated by the unequivocal logic ofthe situation. The calculation is that the adversary will not figure out our actual plan of action. One expects an end combat result which is considerably superior to that which is promised by a decision based on rigorous observance of all the rules of logic. The soldier is aware that in case his plan fails, heavy payment will be exacted for his boldness.

What follows from these military-professional characteristics of risk? First and foremost, the area of applicability of risk is combat with the enemy. But risk is absolutely without legitimacy in flying, operating and maintaining aircraft and in organization of air traffic control. In these domains everything should be rigorously and precisely considered and executed without the slightest degree of approximation.

Combat pilots are not only entitled but are obligated to learn the art of military-professional risk, both during training flights and at air exercises. And they must pay for tactical setbacks: by lost "battles" and by failed missions. That is, by "failures" which should be followed by analysis and evaluation of actual combat proficiency.

A risk to flight safety is a totally different thing.... Let us say, for example, that on a certain type of aircraft stall and spin entry are inevitable with an angle of attack of 30 degrees (an arbitrarily-selected figure). What does this mean? It means that every time pilots risk exceeding the angle-of-attack limitation they will inevitably get into a dangerous operating configuration. Basically there can be no safe outcome. Here it is simply not a question of risk but of an attempt to repeal natural laws.

The same applies to equipment operation, to organization and execution of flight operations support. It applies to everything we call "laws governing flight service." Risk in this domain is unacceptable, foolish, and unprofessional. Not only in peacetime but in a combat environment as well, because risk will result in nothing but casualties and defeat.

The entire history of Air Forces and the present stage of their development demonstrate that competent, thinking command personnel find ways to accomplish continuous combat improvement of the units under their command. They teach the art of risk wherever risk is legitimate. They have an uncompromising attitude wherever unequivocal laws are in effect. They are essentially not simply commanders but scientists specializing in the military aviation profession. Such officers have a difficult life and a difficult job, but that is their human and party choice. And for this reason their commander's concerns are always followed by constant and stable combat readiness, genuine professional skill, and reliable flight safety. Gds Col V. Basov and Col A. Bokach are such officers.

We must also discuss the problem of a pilot's right to make a mistake. Some combat pilots formulate in such no uncertain terms their own firm position in correlating combat training and flight safety.

I feel that in such an abstract form this problem has no persuasive reasonable solution, because the highest degree of combat proficiency and flight safety cannot coexist with an "either-or" formula. Both skill and safety are that unity which is essential to the Air Forces and which we must provide.

Now let us return to the right to make a mistake. The categorical nature of the principle conceals the true picture. In such a formulation one senses a persecution of every little mistake which allegedly wields power over flight personnel and an unavoidable paying the consequences for any deviation from procedures made during a flight. But is this the case?

It we thoroughly examine the very process of flying, in what does this process consist? In what is the pilot mostly engaged in doing during flight? In my opinion flying is a continuous process of correcting deviations in current flight parameters from the desired, intended configuration. Deviations are caused by various things, including erroneous actions by the pilot, who is functioning within a highly complex "pilot-aircraft-environment" system. This is natural, and mistakes of this nature are to be expected. An aircraft possesses not ideal but specific stability and controllability characteristics. And it is subordinated to the pilot's will not directly but via quite real intermediate processes. The combat pilot himself is not an automaton operating with absolute precision and flawlessness, but rather a living being, possessing naturally-endowed and professionally-acquired resources of attention, memory, knowledge, skills and abilities.

In addition, random factors intervene in the flying process. It is for this reason that a pilot makes mistakes. And pilots are not punished for such mistakes. In addition, penalties for making mistakes which can be expected would be absurd.

The function of military aviation is combat, and combat is a contest not so much of machines as of human intellects. And each side does everything it can to make the other side commit a mistake. Is it legitimate uncompromisingly to deny the possibility of miscalculations, that is, mistakes by a pilot in a combat situation? It is not. And this genuine possibility is in fact a right to an entire class of errors.

Unquestionably decreasing the number of various mistakes (including those which can be expected) is the fundamental goal of the entire system of combat, political and moral-psycological training. But to figure that it is possible to attain absolute faultlessness of every decision, action, and move in such a complex domain of human activity as aviation means failure to understand its man-machine nature and its combat functioning.

Are there criteria which define the right to make a mistake? There are! Performance grading standards which have been tested and proven by many years of practical aviation experience and scientific analysis constitute such criteria. It is merely necessary to grasp their not so simple essence. The performance evaluation is not merely a grade of 5, 4, or 3. It is also an indicator of job proficiency, as well as an adviser to command personnel on subsequent work with their subordinates. And it is sometimes a stern judge issuing a verdict of job aptitude.... There is no getting away from it: aviation is a heightened hazard zone and consequently an area of high demandingness on the human factor. Performance grading standards also establish limits on a pilot's right to make a mistake during flight.

World aviation and our own Air Forces have witnessed different approaches to the right to make a mistake. That approach formalized by current regulations has been validated. The methodological elements of the normative approach to flight personnel professional skill are contained in the diagram in the following article.

But there are also fundamentally different mistakes.

...The young pilots and experienced commanders had not conducted joint training in formation flying and had not worked out the forthcoming training flight down to the last details. They took off. And they collided. Are we dealing here with an error in training method and in preparation for flight operations? No, we are dealing with a criminal action against military aviation and military aviators. The fact that this is a criminal act first and foremost against themselves does not diminish the degree of criminal responsibility and does not eliminate the need for the harshest (there is justice in this, although belated) penalties.

...Command personnel and the crew of a special-function aircraft are well aware that it is forbidden to carry passengers aboard this aircraft. But they carry

passengers, proceeding from considerations of "expediency." Let us assume that the flight was uneventful. Does this mean that everything is fine and that no penalties need be imposed?

...The weather situation is changeable and difficult to forecast. But the combat training schedule has not yet been completed. Is it worth taking a risk? To take a risk, in spite of the regulation that a flight operations shift is not to commence unless there is a sure guarantee that each training sortie will end safely.

I believe that there is no right to make such mistakes. And there can be no such right! For the serious-minded individual there can be only one correct and obvious reply to the question of whether it is permissible to test flight safety with a mistake.

But is this not what happens? Certain pilots (or entire subunits) have exhausted the resources for increasing their combat skill within the framework of restrictions established for the sake of flight safety. To remain within the boundaries of these restrictions means to stop improving. And one can clearly see validated possibilities of rescinding certain restrictions which are outdated for a certain segment of flight personnel (the elite professionals). The situation also sometimes occurs where violation of restrictions constitutes a criminal offense while observing these restrictions means diminishing combat power. Neither is in the interest of the homeland. Is there a solution? There is, and a very simple one, that is, without any surreptitious moves. But it is essential thoroughly to substantiate a realistic possibility of reducing existing restrictions. It is necessary to prove that as a result not only professional skills will increase but that the level of flight safety will not drop, that this process will proceed at least in parallel.

More highly-complex training missions and their execution technique must be worked out flawlessly, and a method must be determined for preparing for a new type of training sortie. Here it is logical to expect that innovative training flights will demand double and triple improvement of the methods of preparing for them, and after this one can assume that the road is clear, that obstacles have been removed.

But what if a conservative-minded person in authority blocks the road leading to qualitative improvement in skills? I would say the following: it is not only possible and necessary to knock on any door with comprehensively-supported and substantiated concern for increasing combat readiness and operational efficiency, but it is essential to do so.

Those who truly think progressively and who are able genuinely to embody in actual training flights the fruits of searching, intense, bold innovativeness have many allies. They include personal political, ethical and moral responsibility for the nation's defense capability, as well as mature social content, professionalism which shatters the walls of incompetence, cohesiveness of the collective, and devotion to one's flying career.

Air Forces authorities constitute the first ally and support of everything which increases the combat power of our branch of service. But they are opponents of attention-getting initiatives behind which stands a heavy stream of words instead of growth of the common cause.

Of course there may be those who do not fully share my opinion. And for this reason I believe that one should draw attention to, figuratively speaking, the moral-psychological accompaniment of "prohibitory and restrictive" directives. Thorough psychological effort should help flight personnel grasp the simple truth that a prohibitory regulation as such is born down the chain of command, and is only formalized at the higher echelon. If we are going to fight for fairness and justice, let us do it on the basis of equality, both for subordinates and superiors. Then there will be fewer ultrarevolutionary complaints directed at prohibitory regulations, without comprehension of their difficult substance and without desire to understand the reasons for applying them, without sharing joint responsibility for the unavoidable practice of periodically adopting such restrictions.

At this point persistent appeals are heard to give flight personnel the right to make a mistake, without analysis of the nature of the mistakes proper and without determination of their root causes, with total disregard of the various consequences of various mistakes, without comparing the interests of combat readiness against the considerations of ordinary humanity, without objective elucidation of where we are dealing with a serious work effort and where we are dealing with sheer recklessness, where we are dealing with volition, intense effort, and quest, and where we are dealing with laziness disguised as boldness.

At this point there begins a word game contrasting an attractive image of combat skill and mundane, routine flight safety, with references and argumentation, with claims and assertions.

Combat aviation is a serious business. Every effort is made to ensure that every pilot can become a combat expert, a worthy defender of the homeland. And sometimes uncompromising decisions are needed. But military aviation cannot accept a cavalier attitude toward every element of Air Force affairs. It does not acknowledge attention-getting superficiality. It punishes mercilessly for a great deal. It glorifies and proclaims labor and skill. It prohibits and exposes the pursuit of illusory innovation. The law on innovation in military aviation is extremely simple, just as in any other area of endeavor: support serious action, but give short shrift to idle talk!

Graphic Diagram of Pilot Performance Error

91441150b Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 88 (signed to press 4 Nov 88) pp 24-25

[Captioned diagram: "The Right to Make a Mistake"]

[Text] The expression "To Err Is Human" applies to a pilot, just as it does to anybody else.

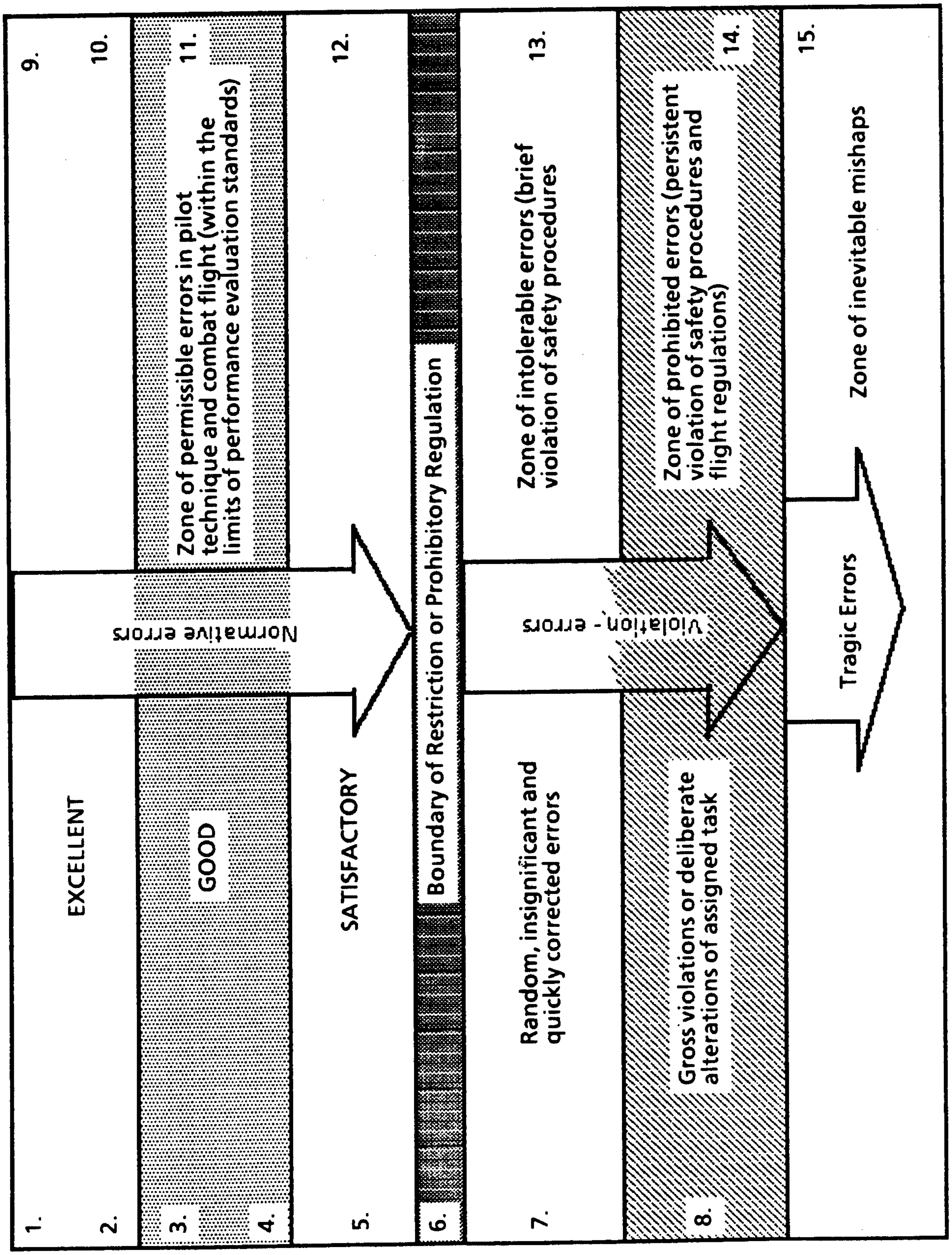
All types of job-related training pursue the goal of ensuring that the combat pilot is able to fly his aircraft (helicopter) without making gross mistakes which lead to dangerous in-flight situations.

The degree of mastery of piloting technique and combat flying and level of deviations which do not create dangerous situations are evaluated by special performance standards. It is these standards which establish the right to make a mistake.

Maximum allowable deviations are governed by restrictions, exceeding which inevitably leads to a mishap-threatening situation. Mistakes which cause such deviations are intolerable and are therefore prohibited.

Mistakes which lead to deviations which go beyond the limits of a prohibitory regulation constitute violations of flight procedures and regulations and signify general lack of pilot proficiency or inadequate preparation for a specific flight, negligence or willful lack of discipline—the essential fact remains unchanged: we are dealing with a violation of regulations.

Cause affects only the nature, extent, and content of measures carried out for the purpose of preventing repetition of a similar violation. In addition, the true cause determines the guilty parties, who bear personal responsibility, and the degree of severity of liability.


1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.
EXCELLENT
GOOD
SATISFACTORY
Boundary of Restriction or Prohibitory Regulation
Random, insignificant and quickly corrected errors
Gross violations or deliberate alterations of assigned task
Zone of permissible errors in pilot technique and combat flight (within the limits of performance evaluation standards)
Zone of intolerable errors (brief violation of safety procedures
Zone of prohibited errors (persistent violation of safety procedures and flight regulations)
Zone of inevitable mishaps
Normative errors
Violation - errors
Tragic Errors

Key:
1. General description of job proficiency in conformity with performance standard evaluation
2. Pilot has solidly mastered training flight assignments of the level of complexity specified for him. Mistakes are minor, random, ascertained by the pilot himself.
3. Comprehensive improvement of job performance is advisable, by increasing proficiency in the mastered types of training and validated increase in complexity of assigned tasks.
4. Pilot consistently accomplishes his flight assignments. Mistakes are minor and are not of a systematic nature.
5. Recommend broadening the range of types of assigned training flights; complexity of assignments in solidly mastered training areas is permissible (with rigorously individualized approach).
6. Pilot performs flight assignments of average complexity without particular difficulties. Mistakes do not cross the boundary of prohibitory regulation, are corrected consciously and with certainty, show a tendency toward permanent correction.
7. Recommend intensive, methodologically well-organized practice flying standard missions. A slight increase in complexity of flight assignments pertaining to certain of the most completely-mastered maneuver sequences is permissible.
8. In the absence of a stable trend toward improvement in job proficiency, a thorough, comprehensive analysis of general job proficiency and preparation of a job aptitude prediction are needed.
9. Principal areas of efforts to improve job proficiency of flight personnel
10. Study, synthesis, dissemination and incorporation of advanced know- how. Advancement to candidate for promotion.
11. Increasing motivation for future improvement in job proficiency.
12. Individual examination of all aspects of job proficiency. Study of the causes of poor proficiency level. Individual work. Warning of adverse job proficiency projection.
13. Determination of guilty parties and bringing strictly to account. Intensification of methodological and indoctrinational work.
14. Analysis and determination of ways to accomplish radical change in system of training, work style of commanders, political workers and personnel.
15. Instituting proceedings against guilty parties across the board for endangering combat readiness and failing to observe flight safety.

Air-to-Air Combat Analyzed

91441150c Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 88 (signed to press 4 Nov 88) pp 4-5

[Article, published under the heading "Into the Military Airman's Arsenal," by Lt Col G. Drugoveyko: "Combat Environment or Tactical Situation?"]

[Text] It is probably useful sometimes to ask oneself simple questions when one is dealing with obvious matters, which long since fail to arouse any doubts. So let us ask ourselves: with what does air-to-air combat begin?

A nice series of ready answers comes immediately to mind: with search, with detection, with the commander's decision.... But all these things have been said many times. And all these things are correct, irrefutable, undebatable. Although there remains a certain discontent, a feeling of a certain excessive clarity.

But with what does combat actually begin? Takeoff, entry into the combat zone, search, detection, closing. Hold it! Perhaps we should turn to an incident at a tactical air exercise.

A fighter element led by Maj A. Arestov entered an area of possible encounter with the "enemy." Airborne radars were switched on. Radar returns appeared on their displays: it was the opposing force.

A combat decision had to be made. There were several tactical variations. Which one should be employed? And what would be the result? But they could also employ a different variation....

At the moment there was little certainty. What tactical elements made up the "threat" formation? Had all "threat" forces been detected? Questions, questions....

Let us analyze this moment in a mission. What comprises the complexity of this moment being experienced by the element leader? After all, it would seem that this experienced combat pilot knows with absolute preciseness the subsequent operational procedure: estimate the situation according to a well-known logical algorithm; reach conclusions from the situation estimate; adopt a battle plan on the basis of these conclusions; communicate his decision to the entire element. Engagement follows. What is taking the element leader so long?

Let us endeavor to examine his situation. Just what does the element leader know? In fact very little. He knows that the "adversary" is flying toward them and that the negative consequences of delay are increasing rapidly with each passing second. Consequently the element leader's situation is conflictive. He lacks sufficient information to make a rational decision, and yet it is dangerous to delay.

We should bear in mind that we are analyzing an event from a tactical air exercise. Obviously in actual combat the conflictive nature of a commander's state will be

intensified and more acute. Or can we rely on decisions being made rationally, courageously and, most important, instantly in an actual combat environment? Hardly....

The acute conflict facing the element leader is not contrived. Let us take another look at that chain of operations which the commander's mind goes through just prior to combat. Situation estimate.... Conclusions.... Decision....

Thus everything begins with estimate of the combat situation. What is the content of this intellectual process? In the most general form it is as follows: adversary—friendly forces—conditions of the forthcoming combat engagement.

Now we can understand why it is so difficult for the professional combat pilot at the moment of searching for a rational decision. We shall cite just one factor in evidence. The space in which the adversary may be located is enormous. Let us assume that it is a hemisphere with a radius of up to 200 km in the horizontal plane. And the enemy may be located at any point in this volume of airspace. Or he may appear within a few seconds. This will totally alter the combat situation. Then an estimate which was flawless a moment before now becomes incorrect. Let us see how Maj A. Arestov proceeded.

One of the plan variations called for splitting up the formation into two elements. According to the plan, the first element would continue closing straight ahead. There are two possibilities for this element. If it can succeed in beating the "adversary" to the punch in launching missiles, it will do so. If the "adversary" seizes the initiative, he must be diverted into pursuit of this element, and when the "adversary" commences to launch missiles, the aircraft must thwart the missiles' homing guidance with violent and complex maneuvering with vertical and horizontal component. The second element proceeds laterally from the direction of attack, slips out of the "adversary's" radar coverage, and mounts a flank attack into the "enemy" force attacking the first group (Figure 1). The plan worked.

Let us analyze the actions of the opposing forces. Why did Major Arestov figure on forcing the "adversary" to follow his plan? Situation uncertainty was equal for both sides, and it was equally difficult accurately to estimate let alone predict development of the combat situation.

I believe that in air-to-air combat (in all phases) it is wiser for the leader of comparatively small force elements mentally to operate not in terms of the integral combat environment but rather a specific tactical situation. This is a segment of the combat environment about which the force commander possesses sufficient information for making a reliable estimate and reaching a substantiated decision.

Let us return to the air-to-air engagement. Arestov knew little about the combat environment if by that we mean its full content (the adversary, friendly forces, conditions). "Enemy ahead" was the entirety of reliable information. Formation, tactical intentions, and many other items are unknown. Was it possible to estimate the situation with certainty in view of such a lack of information? Obviously it was not.

But there was practically no doubt that the "adversary," upon detecting threat aircraft, would not decline to engage. In addition, he could not decline engagement, that is, turn away. And with both forces closing to a

Figure 1. Combat Engagement Variation

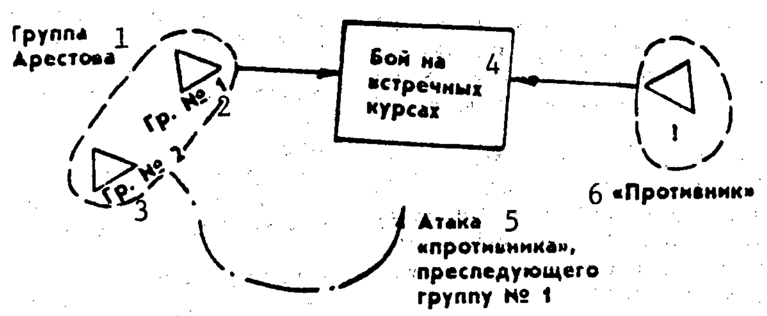


Рис. 1. Вариант действий в бою.

Key:
1. Force led by Arestov
2. First element
3. Second element
4. Forward-quarter engagement
5. Attacking the "enemy" pursuing the first element
6. "Adversary"

forward-quarter intercept, it would certainly be a forward-quarter engagement. This means that, while lacking a complete picture of the combat situation, there was sufficient information to make a partial evaluation. And this tactical situation can be formulated as follows. The "adversary" was flying a forward-quarter intercept course. He had already detected the enemy and would not delay. He would open fire at the first opportunity. This makes it essential to select a response action as quickly as possible.

The situation in which Arestov's force found itself enables us to determine one more important attribute of the tactical situation.

A tactical situation is an element of the combat environment in respect to which a decision must be made immediately, since any delay threatens loss of chances of combat success or outright combat casualties.

One can easily understand that Maj A. Arestov's decision was justified according to this criterion as well.

Indeed, if the forward-quarter closing continues, the "adversary" will do nothing else but a response forward-quarter closing as his initial reaction. Consequently, at this moment the tactical situation logically presumes combat between the two defined force elements. But this kind of combat is too rectilinear a resolution of the combat conflict. The effectiveness of such a head-on exchange of fire is poor and is highly subject to the influence of random factors. In addition, air-to-air duel-type combat is fast-moving and will inevitably transition to close-in air-to-air combat. Therefore why not create in advnace favorable conditions for the principal phase of the engagement?

Precisely for this reason Maj A. Arestov's force was subdivided into two elements. The first element engages and fights a forward-quarter engagement. At the price of a certain degree of risk, conditions are created for an effective attack by the second element. And the overall combat environment thus now breaks down into two tactical situations: an open forward-quarter engagement by the first element and a surprise attack into the "adversary's" flank by the second element. How does the commander exercise tactical control in this instance? The answer to this question is unequivocal. Control is possible only within the framework of a specific combat focal area. Consequently the force leader, having given the command to separate (in order to employ a specific engagement plan), loses the capability to direct all his forces. He is involved in his own engagement and is capable of operating effectively only within that engagement. The other tactical situation is handled by whoever is involved in that situation (Figure 2).

Incidentally, we shall note that at any moment in time each situation may subdivide into several events and require appropriate response: separation of already partial forces into several tactical units and involvement by each new unit in its own particular situation. This process of splitting up the initial formation may even end in one-on-one engagements.

Hence one more characteristic feature of a tactical situation. It is an element of the combat environment in regard to which an adopted decision maintains its expediency. As soon as a plan or decision ceases to correspond to combat interests, as soon as it loses its rational organizing force, as soon as it is necessary to change the sequence of actions (or to correct or adjust something), as soon as one cannot limit oneself to simple response to the adversary's actions—the situation has degenerated and become a different situation.

Figure 2. Involvement of Formation Elements in Specific Tactical Situations

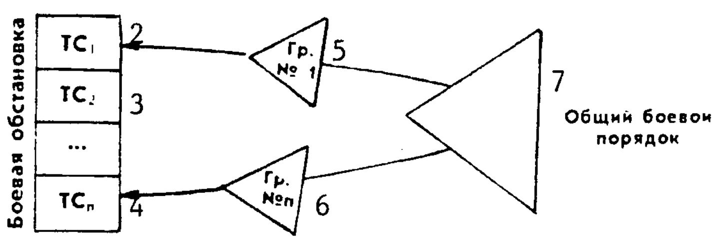


Рис. 2. Включение элементов боевого порядка (Гр.) в конкретные тактические ситуации (ТС).

Key:
1. Combat environment
2. Tactical situation 1
3. Tactical situation 2
4. Tactical situation n
5. Element 1
6. Element n
7. Common formation

Figure 3. Principle of Decision Making in Regard to a Tactical Situation

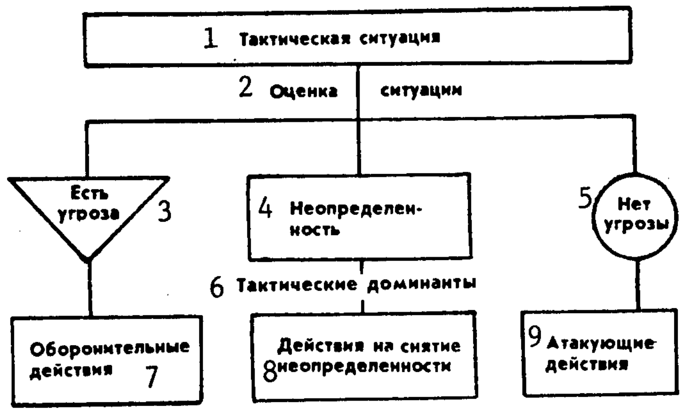


Рис. 3. Принцип принятия решения относительно тактической ситуации.

Key:
1. Tactical situation
2. Situation estimate
3. There is a threat
4. Uncertainty
5. No threat
6. Tactical dominant factors
7. Defensive actions
8. Actions to remove uncertainty
9. Attack actions

The fighters of the opposing force, exploiting certain advantages of position and equipment, succeeded in seizing the initiative in the forward-quarter engagement.

Once again a new decision must be made immediately, based on reliable information. Once again it is necessary to change the organization of combat: to hand over control to newly-formed tactical units, to those combat pilots who have become incorporated into new combat elements.

Arestov gave the command to initiate defensive maneuvering with his formation separating into pairs. He handed over control to the leaders of these two-ship elements.

Just what is a tactical situation analysis algorithm? This is no idle question. If one requires a fully-developed situation assessment, its qualitative uniqueness in comparison with the concept of the traditional combat environment will disappear. The first phase is the situation estimate. This operation is grounded on a well-known logical sequence: adversary-friendly forces-conditions. But analysis of each component of this scheme is substantially reduced and made more specific. The adversary: is there an immediate threat of delivery of fire or not? Friendly forces: what must be undertaken in relation to the estimate of the adversary's situation? Conditions: what promotes achieving the goal determined from the estimate of the adversary and friendly forces, and what hinders achieving this goal?

Second phase: decision or plan proper. Its content includes the following: selection of tactical dominant factor (attack or defensive combat); determination of initial tactical situations and assignment of friendly forces to particular situations; determination of the nature of tactical missions for each friendly forces element and the initial plan of action to accomplish the overall tactical dominant factor (Figure 3).

We shall examine Major Arestov's decision on the basis of the proposed tactical situation analysis algorithm.

Having obtained the most superficial information on the "adversary," but not knowing many factors characterizing the combat environment, one cannot evaluate it fully and reliably. It was logical artificially to simplify, to "reduce" the combat environment to a tactical situation. But it is also impossible right at the outset to reach unequivocal and reliable conclusions on the adversary (whether or not there is an immediate threat). Consequently it is logical to estimate the situation (according to the "adversary's" criterion) in two ways: he may attack; he cannot attack. In conformity with this estimate of the "adversary's" situation, friendly forces are divided into two elements. One takes part in a potential

threat situation and chooses to continue moving aggressively toward engagement, while the other, figuring that there is no direct threat of receiving fire from the "adversary," withdraws from the common formation in order to launch a subsequent attack and prepares to cover the first element if the "adversary" decides to engaeg.

Of the entire aggregate of conditions, meaningful influence on the course of combat could be exerted only by the configuration of the "adversary's" radar-covered area. And a corresponding hypothesis (Arestov did not have a more accurate method at his disposal) formed the basis of choice of direction in which the element which was to become the attacking element should break away from the common formation.

Thus we have two tactical situations. The first is a forward-quarter closing with the "adversary"—offensive combat between the two forces with possible shift to defensive combat. The force commander exercises tactical control of this element. The second situation involves splitting off from the common formation, closing the "adversary" with the objective of attacking from the flank, and readiness to provide cover for the actions of element 1 in case it is forced to wage defensive combat. Tactical control is handled by the subunit deputy commander, who is assigned to this situation.

...Subunit deputy commander Capt I. Kirsanov attacked the "adversary" who, confused by the defensive maneuvers of the fighter pairs of element 1, was unable successfully to analyze the situation and was unable to deliver fire in an effective manner.

Now the adversary was in a defensive posture. But he failed to organize strong opposition. Soon the attacking aircraft were joined by pairs from element 1 which had broken away from enemy fire and were now engaged in separate situations, building up the offensive efforts of their comrades.

The subunit gained victory in this air-to-air engagement.

What is the reason for the defeat of the one side and the mock combat victory of the other? Of course there are many factors in every victory. But apparently the principal role among the many factors involved was played by the fact that Maj A. Arestov's fighters were not fighting a "major war" but were fighting in partial elements of the overall combat effort—in tactical situations.

So where does air-to-air combat begin: with the combat environment or a tactical situation?

Perestroyka in Conversion-Training Bomber Regiment

91441150d Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 88 (signed to press 4 Nov 88) pp 6-7

[Article, published under the heading "Party Affairs: Progress With Perestroyka," by Lt Col M. Khanyukov: "Turn"; first two paragraphs are AVIATSIYA I KOSMONAVTIKA introduction]

[Text] The bomber regiment under the command of Military Pilot 1st Class Col V. Maskayev was an initiator of socialist competition this year in the Air Forces. Personnel were seeking to accomplish two principal interrelated tasks in combat and political training: on the one hand attainment of a higher level of regiment combat readiness to operate in any air and ground environment, and on the other hand activation of the human factor on the basis of democratization of community affairs within the military unit. The men achieved certain success during the first period of training.

The 19th All-Union Party Conference caused a substantial inflow of productive energy and an upsurge in the job-related and sociopolitical activities of regimental personnel. The conference demands focused aviation personnel on improving the qualitative parameters of combat training and achieving a genuine incremental improvement in end results. The regimental party organization, headed by Lt Col M. Khanyukov, assumed a vanguard role. Increased demandingness on one another, frankness, firmness, and businesslike efficiency prevailed within the party organization. All this had a positive effect on accomplishing adopted socialist pledges.

* * *

I have served as party committee secretary for years now. I must state quite honestly that there was a time when I did not derive real satisfaction from my work. At that time there was sometimes more value placed not on concrete deeds but rather on the ability to draw up attractive and grammatically-correct documents and to present flowery-sounding reports. Party work received a powerful impulse following the 27th CPSU Congress and the 19th All-Union Party Conference. It became possible to apply in a realistic manner the strength and influence of the party committee, which had only been talked about in the past. Our activists developed a genuine propensity for practical deeds, for seeking new forms, and an endeavor to move closer toward others and toward practical realities.

Perestroyka has affected the activities not only of the party committee but also of the squadron party buros. In place of the fuss and bustle of show, we began to learn party work methods and more effectively to influence aviation personnel and their attitude in the process of

the changes which are taking place, as well as job-related and community-affairs activeness, while not supplanting commanders and other persons in authority. The end result has increasingly become the main criterion of party work.

In the past party activists sought to encompass all aspects of daily life and combat training activities of personnel with their influence. We lacked the manpower, and frequently we would not so much correct things as draw attention to the problem. In the course of perestroyka we have begun proceeding differently: we determine those party members with whose assistance we want to resolve a given problem, we assign a task to each individual, and we seek to achieve specific end results. On the party committee's instructions, for example, young aircraft commanders are greatly assisted in preparing for carrying out the most difficult flight assignments by party members Lt Col N. Tyannikov, Majs V. Antonov and S. Sherstyakov, and other veteran command personnel.

There are always more problems in the regiment than we can resolve simultaneously. Therefore we attack the key problems. For example, in view of the fact that last year personnel underwent conversion training to a new aircraft and commenced practical mastery of this aircraft, the party committee specified as the main task for each party member and for all party organizations during this period to be in the vanguard of the effort to achieve full utilization of the aircraft's combat capabilities and to ensure flight safety. This is not a simple matter. A considerable increase in combat capabilities is incorporated in the new aircraft, but increased performance is achieved through the highest degree of skill on the part of aircrews and ground maintenance personnel.

The enhanced role of the human factor and the need to activate this factor in every possible way dictated the party committee's decision: to discuss at a general meeting of the regiment's party members organizational and indoctrinational tasks connected with party-political support of combat training and flight safety. And the meeting was to be prepared for and held in an unconventional manner, so that not one single person would remain indifferent to the problems of concern to the unit. Our suggestion was approved by regimental commander Col V. Maskayev and his deputy commander for political affairs, Lt Col V. Bogatyrev.

The keynote address was delivered in the form of a party committee appeal to party members, their experience, consciousness, and feelings. The main points of the keynote address were disseminated in advance, as was a draft resolution and an opinion questionnaire, and posters were displayed in the subunits, calling upon party members to be prepared for a businesslike discussion at the meeting of problems pertaining to mastering the combat capabilities of the new aircraft.

We should state that approximately 200 suggestions were received from party members and party-unaffiliated, and approximately one third of these were considered and adopted soon after the meeting. This has made it possible to improve aircrew training and training facilities and to shorten the time required to preflight-ready aircraft armament and the aircraft as a whole. The combat readiness of aircrews has also increased. Last year there were isolated instances of missiles failing to launch through the fault of personnel, but this year all launches were successful.

Party member suggestions presented at the meeting also served as a basis for holding an expanded meeting of the party committee with the participation of leader-Communists of the regiment and support units. At the initiative of the party committee an efficiency innovator competition was held, which stirred up the innovators' creative energies and focused them on additional innovative quest.

This year the regiment had the honor of initiating socialist competition in the Air Forces. Tough pledges, including improvement of combat performance standards, have required hard work on our part, directed toward mobilizing aviation personnel toward their accomplishment.

Results are already in hand. For example, tactical air exercises have confirmed a genuine improvement in performance standards by 4 percent, and other targets have also been achieved.

Incidentally, not only numerical indicators of combat readiness improvement are important, but also the fact that the men are ceasing to feel that they are blind executing agencies but are becoming involved participants in formulating and executing their own plans.

As our experience indicates, party members are very keenly aware of any changes in the activities of the party committee. Noticing that the party committee is genuinely concerned with seeking ways to accomplish the most difficult and important tasks, the men have begun coming much more frequently to the party committee with suggestions and critical comments. Party meetings have changed. As a rule the men prepare for them in advance. Sometimes as many as 20 persons address the meeting, but their statements are generally specific and meaningful, running from 3 to 4 minutes. The party members themselves terminate empty discussion. The attitude toward party assignments is also changing: a specific assignment is given, and a person is held accountable for carrying it out.

Of course our attempts to approach somehow in a new manner the tasks, forms and methods of party work are nothing other than the first shoots of perestroyka breaking through the soil. Unquestionably the party committee could have achieved greater results from efforts to shorten performance times for becoming

combat ready. At present we are far from fully utilizing our capabilities. Many suggestions by party members have not yet been implemented. Greater efforts are required of the party committee and the primary party organizations, and sometimes we, and this includes me, lack persistence.

There still is a certain tendency evident in the regiment's party organizations: after achieving some improvement, party members tend to rest on their laurels and slacken the pace. Therefore maintaining continuous activeness by all party organizations and all party members in the assigned area of endeavor is seen as one of the problems of perestroyka which must be resolved in the near future.

Tasks pertaining to further improving the quality of performance of alert duty and strengthening combat training in the course of mastering the new aircraft require daily party concern not only with improvement in the professional skill of aircrews and ground maintenance personnel, but also with indoctrination and development of the men's moral-political and psychological qualities.

It was necessary, for example, for the party committee to do a great deal of work together with the regimental command authority to ensure psychological compatibility among aircrew members. We consider the crew party group organizer to be the principal person in this endeavor. It is true that until we begin working individually with the aircrew party group organizers, the influence of the party committee on this category of activist was weak. We have endeavored and are continuing to endeavor to ensure that all party group organizers are vanguard specialist personnel—pilots, navigators, and flight technicians [crew chiefs]. During flight the party group organizer is a political worker at the crew level, as it were. His main weapon is personal example of combat skill, staying power and composure, as well as the weight of the party word in emergency situations.

As a result of well-thought-out placement of personnel, party activists, and party members, we have succeeded in forming aircrews capable of carrying out the most difficult, critical missions. Marks of excellent were received at two out of three recent squadron-level tactical air exercises. A regiment-level tactical air exercise was held, involving repeated aerial refuelings. 45 percent of the aircrews taking part in the tactical air exercise turned in expert-level performances.

This regiment has had no air mishaps in the last 32 years. This has been possible because a system of ensuring flight safety evolved in this unit over the course of many years. It also operates in the party organizations and the party committee. The key elements of this system include work with individuals, as well as immediate response by party organizations to any violations of flight regulations and procedures. Every air mishap-threatening situation is analyzed in detail in our unit, and not so much from the technical aspect as through the prism of the human factor. We determine where, when, and why party and psychological instruments for ensuring a person's reliability failed to operate, and we discuss how to teach the entire body of party activists with this incident.

As a base element in amassing advanced know-how, in the last training year the party committee took under its wing the party activists of the 2nd Squadron, introduced and tested in this squadron what in my opinion is the most effective work method. The party committee sent to the squadron a team of activists, reinforced by headquarters party members. The results of this team's work efforts were discussed at a meeting of leader-Communists and at a meeting of the subunit party buro. Party committee members also presented brief reports to the members of the party buros of the other squadrons, since the shortcomings they had disclosed were typical. This produced positive results.

However, neither regimental commander Col V. Maskayev nor the party committee are satisfied with the state of affairs as regards ensuring flight safety. We cannot relax our concern as long as pilots and maintenance personnel automatically carry over to the new aircraft the mistakes they had been making in operating and maintaining the previous aircraft. Encountering such instances, the party committee drew an important conclusion: problems of ensuring flight safety can be successfully resolved only with the strictest observance of rules and regulations pertaining to flight service by all aviation personnel without exception. Up to this point we had been unable to achieve this.

One of the main focal directions being taken today in the activities of the party committee is to turn to the men, to undertake individual indoctrinational work with party members, and to ensure their vanguard role. What forms and methods enable us to achieve the best results?

We have changed our approach to assessment of the vanguard role of party members. We operate according to the following principle: if performance results improve, the party member is playing a vanguard role, while if there is no performance improvement, there is no vanguard role. All performance marks are displayed. In the aircrews and detachments each party member is given a grade each month for completeness and quality of meeting his individual pledges. Firm, fair demandingness have helped ensure that already this year 60 percent of party members are improving their job performance. Two years ago this indicator of political and job-performance activeness on the part of party members and propationary members was only half as good.

A council of secretaries of party organizations has been formed in the regiment. Its main task is to formulate and clarify to party members the substance, phases, and sequence of restructuring of party work and formation of an ideological foundation and psychological atmosphere for carrying out reforms. It does not duplicate and does

not supplant the party committee. The council meets as needed. For example, at one of its meetings the council discussed the matter of bureaucratic work methods on the part of some regimental headquarters party members. In preparing for this discussion, the party buro secretaries studied the opinions of party members and presented these opinions to the headquarters party buro secretary. The suggestions were correctly perceived as a guide to action.

In the search for ways to resolve current problems, party activists conducted a survey among the principal categories of flight and engineer-technician personnel for the purpose of studying their attitude toward perestroyka. An analysis of the questionnaires compelled us to make certain adjustments in the style and methods of party committee activities.

We have also endeavored to refrain from imposing recommendations and instructions common to all personnel and from handling matters which fall within the direct duties of commanders and specialist personnel, and from superficial study of the state of affairs in the primary-level party organizations. We have changed the criteria for grading the performance of secretaries of party organizations of subunits, detachments, and party group organizers. The party committee grades them on the end results of their job-related work, activeness, cohesiveness, and discipline on the part of individual Communists and the party collective as a whole.

The regimental party organization has established the following procedures: 4 to 6 days before a meeting, party members are familiarized with a report summary for draft resolution, when approving a plan for the coming month the results of achieving targets in the preciding month are totaled up, and party committee decisions are communicated to every paty member.

Activeness and initiative on the part of party members have increased substantially in the course of perestroyka. But we have encountered another problem: lack of conformity between the forms and methods of party work and our organizing ability. We are not yet accomplishing rapid incorporation of all valuable ideas and suggestions. A great many are submitted, and they sometimes overwhelm us. We are not able to respond promptly to all suggestions, and we have not learned how to weed out demagoguery and ill-conceived suggestions presented under the guise of concern about combat readiness, flying proficiency, and flight safety. Sometimes we are unable even at meetings to channel debate and argument into the path of meaningful discussion. We must admit that the body of regimental party activists has in many ways proven unprepared for such work.

Perestroyka has not yet permeated all elements of the party collective. Party committee efforts do not always reach the primary-level party organizations, which also presently lack their own countenance. Efforts to achieve good end results lack adequate ideological support. There are many other unresolved problems. This unquestionably has an effect on specific activities and on meeting socialist pledges. Hence a feeling of dissatisfaction and an ardent desire to eliminate as quickly as possible from party members the sluggishness of routine and inertia, social indifference, and to fight for every individual and for the common cause.

Restructuring of party work in the regiment has begun, and there will be no turning back. There is no reverse gear in aviation.

Executing a Loop With Crosswind Component

91441150e Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 88 (signed to press 4 Nov 88) pp 8-9

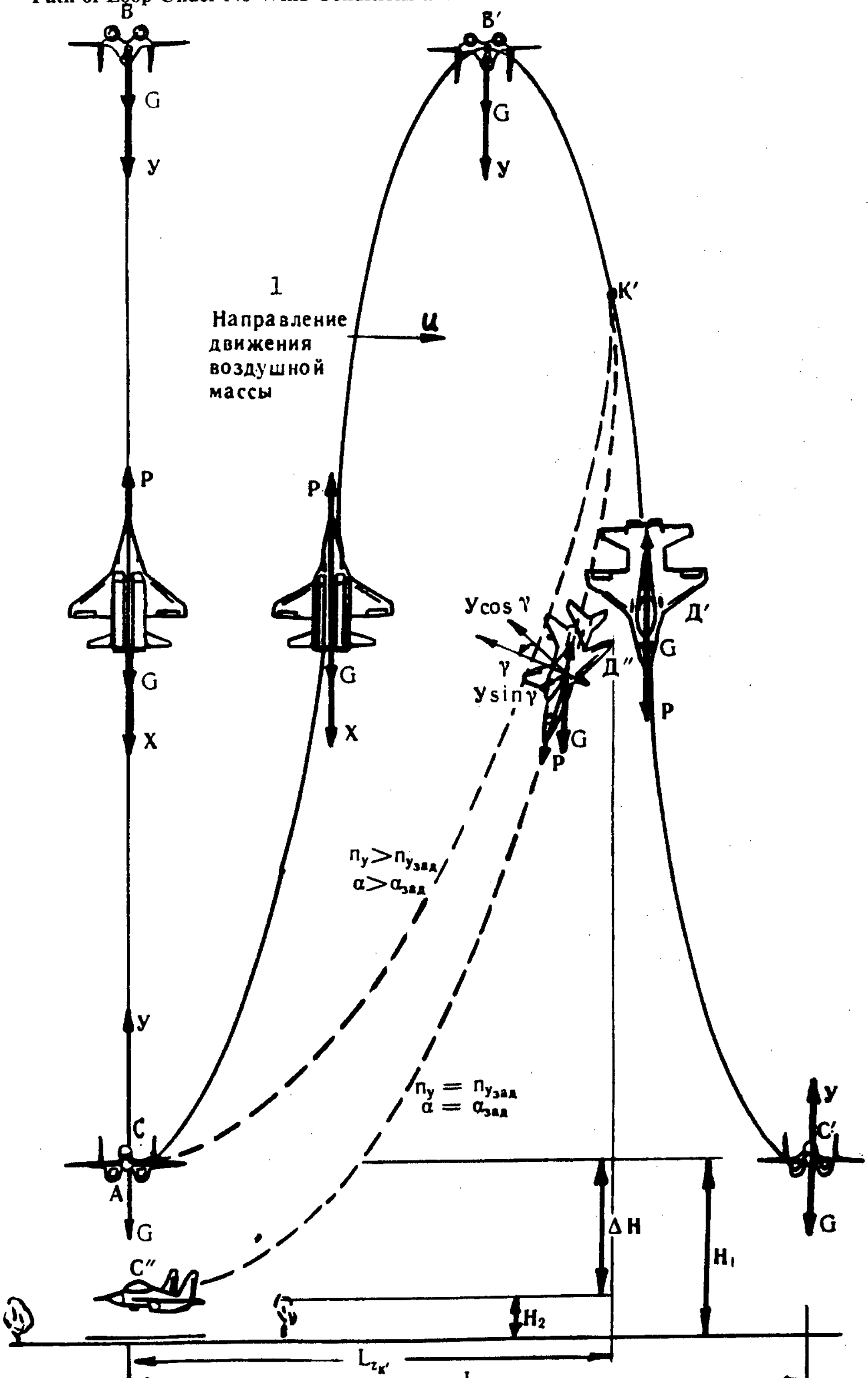
[Article, published under the heading "Practical Aerodynamics for the Pilot," by Military Pilot 1st Class Maj A. Ziziko: "Modified Loop"]

[Text] 75 years ago Russian pilot Jr Capt Petr Nikolayevich Nesterov flew a so-called loop-the-loop for the first time in world aviation history, with this feat ushering in the era of advanced aerobatic maneuvers. Regular employment of this maneuver with various parameters is not an end in itself for the pilot of an aircraft with aerobatic capability. It is merely a part of training to execute a specific combat maneuver. Is the loop always a simple maneuver?

The loop is an aerobatic maneuver during the execution of which an aircraft, as we know, describes in the vertical plane a closed curve positioned higher than the point of entry. When working on flight path problems in flight dynamics, one generally employs both a standard terrestrial system of coordinates and a standard coordinate system. Definition of a maneuver does not prohibit "tying in" the vertical plane of the maneuver both to the ground surface and to the aircraft's center of gravity. In the former case the vertical plane is positioned in a terrestrial coordinate system, and the pilot will endeavor to execute the maneuver above a specific reference point (generally linear) located on the ground surface. In the latter case the loop is executed in a standard (the term "trajectory" is frequently encountered in textbooks) coordinate system. Here the maneuver should be executed with wings level.

Let us mentally execute a loop at low altitude. In any case, in conditions of dead calm, the aircraft's flight path will be as curve ABC in the figure. Incidentally, point C does not necessarily need to be higher than point A. Its position is determined by the control function and speed on the descending part of the loop, and therefore the terminal portion of the flight path may be positioned lower than the entry point.

Path of Loop Under No-Wind Conditions and With Lateral Movement of the Air Mass.



Траектория петли Нестерова в штиль и при наличии бокового движения воздушных масс.

Key

1. Direction of movement of air mass

Now we shall examine the trajectory of a loop in the presence of a crosswind component. When executing the maneuver with a zero angle of bank (all other conditions being equal), the aircraft's flight path is depicted by curve AB'C'. In this case the vertical plane is not tied in to the maneuver entry and exit reference point but is tied to the aircraft's center of gravity. In relation to the ground surface, exit point C' will be displaced from point C (maneuver entry) by the following amount: Lz = u x tn (M), where u is the crosswind component (m/s); tn—loop execution time (s).

Is it possible for the flight path, in the presence of a crosswind component, to fall within a vertical plane tied to a reference point located on the ground surface? The answer is unequivocal: it is virtually impossible. The main reason for this is the fact that the pilot would have to fight the wind, continuously altering his angle of bank during the maneuver in relation to the crosswind component and the aircraft's current airspeed, and this is extremely difficult to do.

In practice there are instances when a pilot executes the first part of the loop with wings level. The aircraft travels along curve AB'. In the second half of the maneuver, when the ground surface and the designated reference landmark on the ground surface enter the pilot's field of view, in order to pass over the reference point the pilot begins to turn, establishing an angle of bank (point K'). The bank angle depends on lateral drift Lzk and wind velocity, since the moving air mass continues to carry the aircraft laterally. Tie-in to the reference point can also be performed upon approaching pitch angles close to 90 °, when the airplane silhouette on the flight director turns 180°, where for a certain period of time it is impossible to determine with the flight director the exact bank angle. We should note here that the pilot may think that the drift from the designated reference point has been caused by a nonexistent error in maintaining zero bank angle during the first half of the maneuver. In addition, exact current wind speed and direction values in the practice area are generally not known.

Thus when turning the aircraft toward the designated reference point, the force which bends the maneuver trajectory in the vertical plane with the previous specified pattern of G-force change, is less than total lift on the aircraft, since part is used for bending the trajectory laterally (point D in the figure). As a result there is greater loss of altitude in the second half of the loop. In order to recover to level flight at the specified altitude and above the designated reference point, the pilot must increase the positive G force (in some cases beyond the predetermined value). And it is also possible that with a loss in airspeed the aircraft may assume an excessive angle of attack.

All this diminishes flight safety, particularly when executing a maneuver at low and extremely low altitude, as well at close to the edge of the performance envelope. One can assume that a portion of air mishaps and near mishaps due to entry into critical and beyond-critical flight configurations are connected precisely with failure to consider the flight dynamics in the presence of wind and when tying the aircraft's flight path to the ground surface.

When executing a loop maneuver at low altitude, flight personnel should pay particular attention to the following methodological recommendations: the maneuver should be executed with wings level, especially when there is little altitude available for maneuver recovery; the pilot should designate a reference point on the ground surface only for the purpose of determining the general direction of exit from the maneuver; the pilot should fly the third quarter of the loop maneuver precisely, in order to avoid a considerable loss of altitude on the descending part of the loop; if altitude and airspeed are incorrect at the top of the maneuver, the pilot should terminate immediately and not execute the descending portion of the loop; the loop should also not be executed close to the ground surface on a training sortie when operating at maximum configurations as regards G load, angle of attack, and airspeed.

When there is a crosswind component, the recovery point will be displaced downwind somewhat. If it is necessary to exit the maneuver above a specified point (object) on the ground surface, the entry point should be displaced by the amount of wind drift, utilizing information on wind speed and direction.

Officers Urged to Treat Subordinates With Tact and Kindness

91441150f Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 88 (signed to press 4 Nov 88) pp 14-15

[Article, published under the heading "Topics of Ethics," by Col V. Anokhin, senior instructor, Air Forces Political Directorate: "And the Word Will Ring Out...."]

[Text] ...Two lieutenants were discussing an air-to-air combat tactic. Each was arguing the advantages of his variation. And suddenly....

"What you are suggesting is garbage, pure bull!"

That was it: the debate died, and a quarrel was born.

...A party meeting was in progress. Party members were criticizing the commanding officer for the fact that through his fault many initiatives on the part of his

subordinates had not been implemented. Somebody used the word conservative in reference to this approach to innovator suggestions. The commanding officer jumped up, interrupted the speaker, and shouted at everybody: "What, are you staging a coup? There will be no coup. I am a one-man commander. My word is law. No democratization is going to rescind military regulations. And as for initiative and suggestions, they aren't worth a damn!"

The frank party discussion came to an abrupt halt.

...The flight commander approached the young pilot, in partnership with whom in a two-ship element he had just fought an air-to-air engagement. He rated the young pilot's performance: "Lousy flying!" and hurried off to his duties.

The pilot made his way "upstairs." Witnesses to this unique after-action critique gazed after him, some with sympathy and understanding, and some with a dry smile.

...Night flight operations had ended. The clock showed 0230 hours. The regimental commander was winding up the post-operations meeting: "Tomorrow all personnel are to report to formation as usual: at 0830. Any questions?"

One of the officers stood up: "It is already 0230. By the time we get home.... People will be getting to sleep about 0400. And if they have to get up to make morning formation.... That is only 3 hours of sleep. Could formation be a little later?"

The commanding officer was unyielding: "Don't start telling me about the right to rest. I repeat: formation is at 0830!"

There is plenty of food for thought here.... First some of the details. Does the lieutenant, a graduate of a higher military school, who has completed a course in air-force tactics, not know that a claim to possess the only correct solution in air-to-air combat is an absurdity?

Was it worth it for the party member to destroy the professional respect of his colleagues and diminish himself as a party member?

And when will the psychological wound inflicted on the young combat pilot heal, inflicted by a person on whose assistance one would so much like to count in any situation?

And is not concern with the sleep and rest of one's men not just as much a commander's strength as his unbending will?

These are particular points pertaining to the cited incidents. But they contain something in common, which pertains to lieutenants and majors, colonels and generals, to everybody who is quick-tempered, rude, and lacks self-control. Right at the outset perestroyka first and foremost linked man with deed, and therefore called all components of character and personality to account. If the link between man and deed is to become reality—the fate of perestroyka will be determined both in the civilian domain and in the military. If it does not become reality, one must look for objective reasons.

Particularly valuable among the qualities of every member of the military, qualities which are of great importance today, is the ability to communicate.

What kind of communication? Job-related, formal or informal? We shall state things in simple terms, at the risk of having criticism leveled at us by specifics-focused opponents. We shall reduce all kinds (types, classes, categories) of intercommunication to a single category—human intercommunication, since everything begins with man, on the job and in the collective. Things also end with man.

But let us return to those quite simple incidents with which our discussion began.

Two lieutenants are engaged in debate. What better method to search for the truth? In refuting the opponent's arguments, one bolsters one's own arguments. But you do not firmly establish your own arguments alone, but with the assistance of your comrade. By coming forth with counterarguments, he is testing and adjusting your own conclusions. If you closely and honestly analyze a debate which has reached its conclusion, you will without fail note that (even if you have emerged victorious in the intellectual contest) you have come out of the debate a bit different from when you entered it. Be that as it may, something has changed, become improved, stronger. Your opponent deserves credit for this. And the more refined and sophisticated your opponent's refuting arguments, the more has been gained by your initial idea.

Debate is always a joint creative process. It is not a calm process, to be sure, because there is no kowledge which is uncolored by emotions, especially when the subject of debate is not only conflictive, not only interesting, but also close to your heart. Such as, for example, a tactical move for a military pilot.

But in our example emotion gained the upper hand over both professional interest and over reason. And then an insulting remark ensued.

Debate with the assistance of jabs at one's self-esteem is unprofitable even from a pragmatic point of view. Truth is born in debate. Truth dies in insult. And words can inflict great injury.

Take the commanding officer's angry words at the party members.... The commanding officer is hardly an opponent of perestroyka. If so, then what is the point of discussion? He simply is unable to handle the flood of complex elements, the unaccustomed rhythm of our time.

How did party meetings go in the not so distant past? Everything was highly organized and presented in neat little doses. Moderate criticism, to the point of agreeability. Trivial (or excessive) suggestions and proposals. Languid discussion. Fleeting vote: "Adopt as a basis"—unanimously, "on the whole"—the same forest of upraised hands. Nobody expected anything of practical benefit from anybody else (or from oneself). They would sit around a while, talk a bit, and disperse.

Today we get a great number of practical suggestions: precise, specific, and needed. Any proposal presented by a person of initiative becomes for him a meaning of life.

But what if a new innovation is not implemented? Who is the guilty party, who is the conservative voice? We have not yet learned to blame and reproach ourselves. But who is going to do it? The commanding officer, because he stands at the top. And of course thunder and lightning rain down upon his head.

At this point the commanding officer explodes. He is unable to hold up under contact with truth (or error—this also happens) on the part of his subordinates. He lacks the calmness to draw new allies over to his side in the campaign for combat readiness, for professional skill, for intensification of combat training. And when the commanding officer exploded....

This is followed by mutual hostility. The chasm grows wider and deeper. Word of mouth unfairly attaches to the commanding officer the label of retrograde and mossbacked conservative. His subordinates plunge into a state of skepticism and distrust. This causes nothing but harm to the performance of military duty, anf yet it seems all to have been caused by just a few uttered sentences....

The flight commander lashed out at a pilot who had experienced problems on a training sortie.... He did not help the pilot find the reason for the problem, but merely passed sentence. And, knowing the psychology of flight personnel, this sentence extends not only to that one flight which ended 30 minutes previously. Pilots know that flying requires a certain natural talent. Especially precise reaction, keen coordination, stable spatial orientation, and many other things. And now suddenly—lack of ability! This one little statement will engender a great many self-doubts in an officer who is just commencing his difficult career.

To those difficulties with which every flight is replete will now be added uncertainty about one's own ability. Military aviators are no shrinking violets. It is a profession for courage and fortitude. But combat pilots form these qualities for confrontation with the enemy, or for encountering those unforeseen situations which can crop up suddenly during flight. We are open and defenseless before our commander and friend. But when courage and fortitude are needed following a brief verbal exchange with that person who is closest to us by nature of the military structural edifice, our mentor and adviser.... Such incidents do not improve fighting qualities but demolish them.

Mistakes require commander analysis, the effort of experienced, veteran thought process, but they do not call for irritation, and they do not call for demeaning attack, or hasty, angry words uttered due to lack of restraint.

The regimental commander failed to think about legitimate rest and sleep for his men, which, incidentally, is prescribed by regulations. Of course at the designated time the men froze at attention as their commanding officer appeared. They listened as the day's schedule of activities was announced. And they carried out their assigned duties. But who will check and compare to determine whether they did their job better or worse than usual? But that enthusiasm, that positive mood, when everything moves rapidly and well, was lacking. And for some reason none of the men had any thoughts or concern about the job after the work day, specified in the day's schedule, came to an end. Yes, their superior officer's command and will remained unshakable. But what about the men's attitude? What about their professional respect? What about respect for one's superior? What about the results of the job performed?

What will pass on to the future of this unit as profit from the capital of commander demandingness?

How did it all begin? It began quite simply. The commander announced his decision. He wanted that decision to be reinforced by common agreement. But suddenly he did not hear what he was expecting to hear. And each word of disagreement was interpreted as questioning of orders, undermining of authority, and immature discussion.

Here are two more examples of incidents which have occurred, but of a different kind.

Lt Col A. Grigoryev was approached by one of the enlisted men: "I don't know how I can go on. My fiancee got tired of waiting and married somebody else.... We had been together since childhood!"

Probably many of us would have turned the conversation into lighthearted banter, such as: "You don't know how lucky you are, soldier. There's plenty of women to go around!" But this would not only belittle his feelings, but you would also lose his trust. But others, deciding that

the soldier could not simply be dismissed without relieving him of the burden of what was perhaps his first disappointment, would say something to console him, and would say the right thing, that which needed to be said.

But Grigoryev replied: "To be quite honest, I don't know how I can help. And is it really possible to help in such a situation? But I do know from my own experience that you will get over it. You will get over both your sense of misery and your pain. Sometimes grief lasts for a long time. But in the end it yields and becomes dulled. Gradually grief diminishes to sadness, and one can live with sadness. Why don't you try, Nikolay, to see if you can get through this. If after a week or two your grief does not diminish, come back and see me. The two of us will talk over what can be done."

The soldier did not approach him again with his pain. His sole reaction to the experience was to do his job well. His commanding officer, however, noted a grateful look in his eyes henceforth. And the trust and confidence of all the compulsory-service personnel seemed to grow stronger. This also is the possible result of a brief conversation....

A private by the name of G. Tashayev served in the squadron under the command of Lt Col S. Arabyan. Tashayev did not exactly have an eager attitude. It is true that he did not commit any serious offenses, but he was constantly committing minor breaches of regulations. He would be late reporting for duty, he would fail to finish an assigned job, or he would forget to do something. He would fail to notice something, not quite make it on time, or fail to think about something. Explanations, attempts at persuasion, analysis of performance, critiques, and punishment failed to diminish this indifference toward military service. But once....

On that day Lt Col Sitrak Miskhakovich Arabyan was handing out prizes to the subunit's best athletes. After the ceremony he turned to Tashayev: "Tell me, Comrade Tashayev, by the end of your military service are you going to bring even a little bit of pride to the squadron? Some badge or pennant? Or can we expect nothing but breaches of regulations from you?"

A miracle happened. The soldier became a new man. He was not put on report a single time right up to his discharge. And even.... The subunit had been called upon to help apprehend a dangerous criminal. The search continued into the night. A truck carrying Tashayev along with other soldiers was proceeding slowly along a road. Tashayev spotted a figure hiding in the bushes at the side of the road. He instantly leaped over the side of the truck onto the suspicious figure. He took the man entirely by surprise, knocking him down with the weight of his own body. He had him in custody before his comrades reached the spot.

The fact is that Tashayev was neither a professional stunt man nor an expert at hand-to-hand combat. It seems that one could expect real deeds of this man. It was merely necessary to arouse in him the desire to do so.

Just what is military service? It is the entire life of a military man. But life does not boil down to orders and is not governed and regulated point by point. Herein lies both the complexity and the depth of the military environment.

But military service also is continuous intercommunication of persons of differing job and position but equal in right to dignity. They are dissimilar in facial appearance and experience, but they are indistinguishably alike in perception of a commander's wisdom and concern, comradely attention and sensitiveness. For this reason every word spoken by a superior or fellow soldier will definitely evoke a response. He will respond with deeds, or he will respond with whatever this word arouses in the soul of a military man. In other words, he will respond with deeds.

Proposed Method of Evaluating Flight Safety

91441150g Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 88 (signed to press 4 Nov 88) pp 18-19

[Article, published under the heading "Flight Safety: Experience, Analysis, Problems," by Military Instructor Pilot 1st Class Col N. Litvinchuk, Candidate of Technical Sciences, and Col S. Shumilo, Candidate of Technical Sciences: "One Can Evaluate Objectively"]

[Text] Flight safety depends in large measure on the degree of objectivity of evaluation of the state of flight safety. Existing methods of such an assessment (statistical, probability, expert) contain many flaws: subjectivism, incompleteness, and one-sidedness.

Here is an example. A pilot touched down short of the runway. This constitutes a mishap-threatening situation. But according to existing regulations it is irrelevant how far short of the runway threshold touchdown occurs, 100 meters or 10 meters short. And yet the actual hazard differs.

Or take the following incident. One commander reports two near-mishap situations, while another reports 10. It would seem to be obvious in which unit the situation is worse. But this fails to consider the true hazard or danger presented by the various violations.

But is it impossible to increase objectivity of analysis and evaluation of the state of flight safety? I believe that this can be done. But it is necessary to employ an improved, more scientifically substantiated method. We shall illustrate with a specific flight (Figure 1).

In the process of maneuvering, a pilot kept exceeding the maximum allowable angle of attack. In connection with this the flight situation periodically became critical. At a certain moment he reached a stall angle. The aircraft entered a spin. The situation became dangerous. But it was still possible to recover from the spin. The pilot was unable to recover, however, before passing through the altitude required to reestablish level flight. An emergency situation ensues as this point: the aircraft can no longer be saved, but the pilot can still safely eject. The aircraft continues losing altitude. If the pilot does not eject before reaching a certain minimum altitude, a tragic outcome will ensue.

Let us examine the theoretical premises of the proposed method.

A flight and any segment of a flight (flight situation) can be characterized by a set of parameters which change with time. Their required change is determined by the mission assignment. Whatever hindrances may arise in the functioning of the "pilot-aircraft environment" system (mistakes by aircrews and ground controllers, equipment malfunctions or occurrence of random factors), in the final analysis they are all reflected in the flight parameters and shape a specific flight situation.

Each flight parameter has its limits. Attempts to exceed these limits are dangerous. For exmaple, an excessive angle of attack can cause stalling, loss of stability and controllability; exceeding maximum G load can cause an aircraft to break up or cause structural deformation; exceeding maximum range limit results in fuel exhaustion.

The aggregate of limits can be represented in the form of surface of limitation, which can contain multiple parameters. The configuration of such a surface is complex, since it comprises a multiple-factor mathematical relation. One can use one- or two-parameter surfaces without employing a computer, or three-parameter at the very most.

Approaching a surface of limitation complicates the flight situation and increases its degree of hazard. Even crossing the boundary, however, does not mean that an air mishap has occurred. Very few parameters have critical values. These include restrictions in maximum speed and Mach number, vertical rate of interaction with the ground surface, etc. They are closely linked to other flight parameters, however, and are affected by them.

These surfaces of limitation characterize a flight situation as a complication, danger, accident, or fatal accident. This is shown in Figure 1.

Depending on circumstances, situations can be analyzed as events which have already taken place or as anticipated events. In the former case one utilizes information obtained from flight data recorders, crew members, and eyewitnesses. In the latter case the situation and its

Figure 1. Proposed Classification of Abnormal Flight Situations.

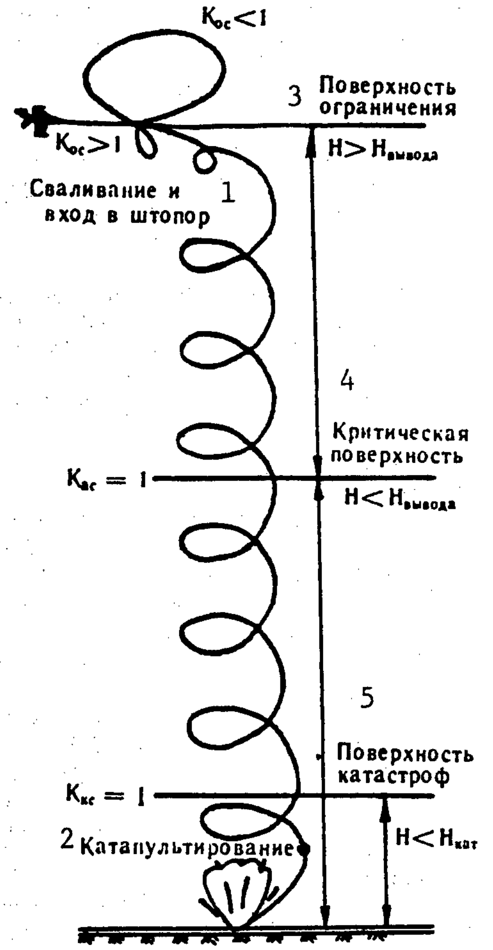


Рис. 1. Предлагаемая классификация нештатных полетных ситуаций.

Key:
1. Stall and spin entry
2. Ejection
3. Surface of limitation
4. Critical surface
5. Surface of fatal mishap

degree of danger are predicted with the aid of an onboard digital computer as the end result of change in flight parameters. Essentially a pilot is constantly doing this intuitively during flight (on the basis of his experience or by performing calculations.

This method makes it possible to establish personal surfaces of limitation, proceeding from each pilot's level of proficiency. And this will be an objective determination of safety measures.

Selection of a quantitative criterion for estimating degree of situation danger can be illustrated well graphically (Figure 2).

Figure 2. Examples of Limitation of Paramaters and Determination of Flight Situation Evaluation Criteria on the Basis of These Parameters.

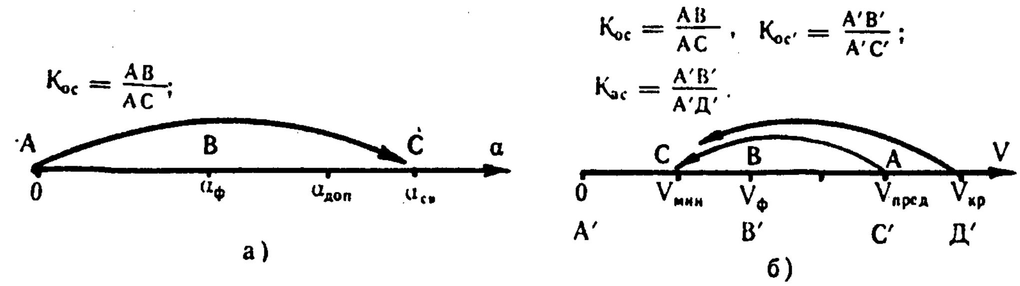


Рис. 2. Примеры ограничения параметров и определение по ним критериев оценки полетных ситуаций.

An arbitary (preselected) parameter value is selected proceeding from the physical substance of a limitation or restriction. For example, a zero position is most frequently taken as an arbitrary value in determining given criteria for maximum restrictions (Figure 2a).

The extreme (maximum) value of a given parameter is adopted as an arbitrary value in determining criteria for minimum restrictions (Figure 2b).

In certain cases, such as during route-prescribed cross-country flights, the preselected flight level is selected as arbitrary value, and boundaries between assigned flight levels are adopted as surfaces of limitation.

In establishing complication criterion and situation danger criterion, it is advisable to adopt allowable or maximum parameter values as surface of limitation. In selecting accident criterion—critical values which lead to structural breakup of the aircraft. And fatal accident criterion—critical values taking into account the possibility of saving the lives of crew members (Figure 1).

The surfaces of limitation, as well as their approximate interlinkage with the flight safety probability criterion, are shown in Figure 3 (using normal load factor in our example).

Figure 3. Critical Surface and Surface of Limitation With Absolute and Probability Approaches to Evaluating Situations.

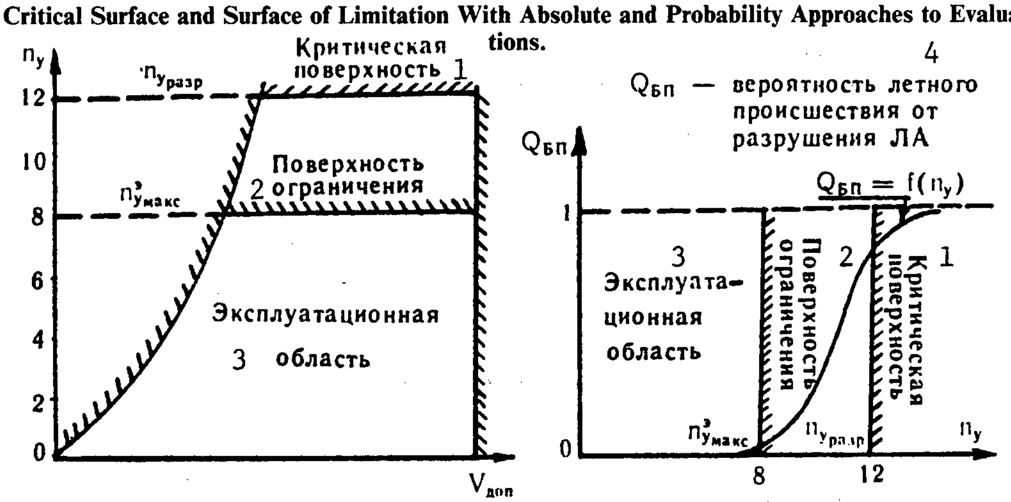


Рис. 3. Критическая поверхность и поверхность ограничения при абсолютном и вероятностном подходах к оценке ситуаций.

Key:
1. Critical surface
2. Surface of limitation
3. Normal operating envelope
4. Probability of air mishap due to aircraft structural failure

Let us examine examples of determination of individual

$$K_{oc} = \frac{AB}{AC} = \frac{\alpha_\phi}{\alpha_{св}} \; ; \; K_{oc} = \frac{V_\Gamma}{V_{пред}};$$

$$K_{ac} = \frac{V_\phi}{V_{кр}} \quad K_{ac'} = \frac{AB}{AC} = \frac{V_{пред} - V_\phi}{V_{пред} - V_{мин.\,доп}},$$

criteria with formulas in conformity with Figure 2:

where: α_φ and V_{gf}—actual value of angle of attack and airspeed.

If the criterion falls numerically between zero and 1, this means that the situation has simply become complicated. A dangerous situation ensues at a value of 1 or more—a sign warning of an air mishap. In objective terms this is a mishap-threatening situation.

The criteria of accident and fatal accident behave in like manner.

The actual degree of difficulty of a flight assignment is also evaluated in the same manner. The preselected value is adopted as the actual value of a parameter. The degree of complexity, unless explicitly specified in the mission assignment, cannot be equal to or greater than 1. In the general case it is selected with reference to the pilot's level of proficiency, with a safety margin.

In order to simplify working with these coefficients it is expedient to use only one surface of limitation based on extreme or critical parameter values. For example, when tying a criterion directly to a maximum restriction, its value up to 1 characterizes situation complication, a value greater than 1 up to a certain value (critical) characterizes a danger situation, while a value above the critical value indicates accident and fatal accident situations.

If it is determined in the process of analyzing execution of a given flight maneuver that the pilot has entered a configuration whereby several danger criteria have reached a value in excess of 1, this means that several preconditions for air mishaps have occurred simultaneously.

Let us turn to practical utilization of the proposed method.

In formation flying, for example, the boundary of the region of dangerously-close approach can be taken as surface of limitation, and the region of potential collision can be taken as critical surface (Figure 4).

During route-assigned cross-country flight, with altitude separation, adjacent assigned flight levels will constitute the boundaries. When flight level boundaries are crossed without authorization, danger criteria become greater than 1, and a mishap-threatening situation is indicated, with a corresponding degree of danger.

When practicing aerobatic maneuvers (combat maneuvering, etc), danger and accident criteria are determined for all parameters, after which graphic or analytical relations are plotted in relative or absolute values.

A similar approach is also applied to the operating parameters of other elements of an integral aircraft system. For a pilot, for example, minimum visibility, cloud bases, maximum G loads, etc, specified on the

Figure 4. Evaluation of Separation Distance Situations During Formation Flight.

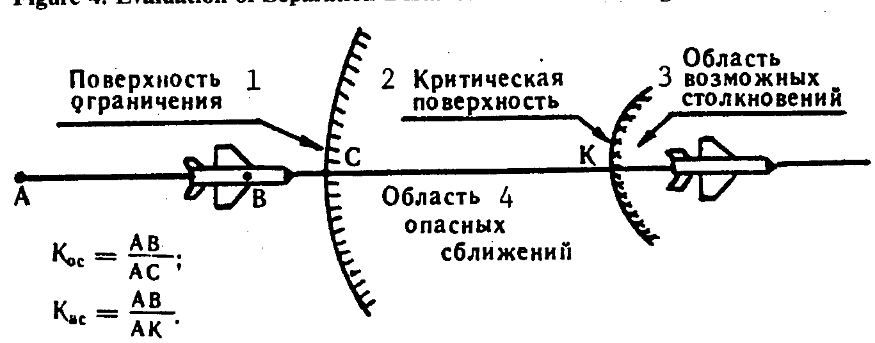


Рис. 4. Оценка ситуаций по дальности в групповом полете.

Key:
1. Surface of limitation
2. Critical surface
3. Region of potential collisions
4. Region of dangerously-close approach

basis of proficiency level or safety considerations, constitute the surface of limitation. Restrictions conforming to human capabilities: visibility, cloud bases, etc are used as critical surface.

Applied to the aircraft and the "aircraft-environment" subsystem, surfaces of limitation will consist of minimums for the aircraft and the airfield, maximum crosswind, tailwind, and headwind components, and maximum load. Evaluation of criteria is analogous to the first case.

When degree of danger of future flight situations is being predicted, one determines the anticipated value of a parameter up to the moment it ceases changing. It is more convenient to employ as criterion of danger the ratio of time of delay by the pilot in intervening in control to total available time—the maximum time available to the pilot from the moment an adverse factor occurs to commencement of actions to counter its consequences (under the condition that the determining parameter reaches but does not exceed its maximum value).

The proposed approach to evaluating flight situations differs somewhat from the generally accepted method in the Air Forces. Its capabilities are substantially greater. With a criterion approach one of the most important areas of flight safety is resolved—an objective quantitative assessment of the degree of danger of a flight situation. A quantitative evaluation of level of flight safety is possible, not only on the basis of air mishaps but also by degree of situation complication and degree of hazard of situations in flight, as well as automation of the process of evaluating hazardous situations and their cessation with the aid of an onboard digital computer in flight, as well as on the ground based on flight data recorder tapes. This method will increase the responsibility of command personnel and flight personnel in analyzing flight situations and mishap-threatening situations. Since these criteria are dimensionless quantities, they can be added up regardless of type of aircraft and flight parameters, general graphic or analytical relations can be plotted, and the general level of flight safety can be evaluated.

The first level of flight safety evaluation falls within the competence of the commander of the air unit or subunit. To make their job easier, it is advisable to have graphs, nomograms or tables for specific types of aircraft in order to evaluate the hazard of various mistakes and violations of procedures. The same approach can be used to evaluate flying technique.

The second level of evaluating flight safety falls within the competence of scientific research establishments. On the basis of data from the first level, one determines the level of safety for the Air Forces as a whole, by military aviation elements and components, types of flight assignments and flight maneuvers, performs study and refinement of surfaces of limitation, and elaborates measures to improve flight safety.

Problems of Pilots Maintaining Spatial Orientation

91441150h Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 88 (signed to press 4 Nov 88) p 20

[Article, published under the heading "Flying and Psychology," by Maj (Res) A. Plentsov, research engineer: "Loss of Bearings?"]

[Text] In aviation there occur a good many unpleasant situations connected with disruption of stable control of the aircraft. Among the factors leading to hazardous situations in the air due to disruption of the process of flying the aircraft, loss of spatial orientation is considered to be the most common. Is this true? In order to answer this question one must thoroughly analyze how aircraft autonomous control is accomplished.

The "pilot-aircraft" system functions on the basis of three models of flight: conceptual (KMP), operational (OMP), and informational (IMP). We shall examine them in detail.

A conceptual model of flight is a speculatively created long-duration model. It is formed on the basis of preceding vital activity, knowledge of aircraft dynamics and control, practical flying experience, and the specific flight assignment. KMP is a kind of matrix which contains a large number of units and cells, each of which stores information on a specific flight task.

When flying, information is obtained in a specific sequence from the appropriate unit—a cell or group of cells, is processed and proceeds to the brain's comparison and decision center. The greater the total number of units and cells and the more densely packed they are, the more extensive and higher quality the matrix, and the higher the degree of professionalism.

The moment of a pilot's readiness for his first solo flight or to advance to new levels of flight training can be determined by his ability to form a KMP. The structure of the KMP and the degree of sophistication of acquired motor skills are interlinked and comprise coordinated links of the overall aircraft control chain.

...A pilot prepares on the ground to fly advanced aerobatic maneuvers. By manipulating a model aircraft he mentally pictures, let us assume, the process of executing a loop. He holds the model aircraft pointing away from him, that is, he observes it from aft in the direction of movement. At the top of the loop, when the airplane turns its nose toward him, the pilot himself turns and once again observes the aircraft from the rear. This

observation of an aircraft's position and motion in space is the most typical for pilots, since in this instance they simultaneously see the fixed line of the natural horizon, the ground, and the airplane displacing relative to the horizon and the ground. Thus it is easy to determine the spatial attitude of the aircraft and its subsequent direction of movement.

Thus the pilot forms the structure of a KMP from the outside, as it were. The pilot observes and commits to memory the position of two elements simultaneously, from the rear along the path of movement. Subconsciously—the principal, fixed element: the position of the environment, and consciously—the additional, controllable and, consequently, moving element: the position of the aircraft. The first element of the KMP serves as a unique base, a scale for determining the position and motion of the second element.

In forming a KMP the pilot, conforming to its structure, also develops motor skills in controlling the aircraft. They are also coordinated with the experience of preceding vital activity and are subsequently confirmed by actual flying.

The motor skills which are developed in the course of training are coordinated with the acquired concept of flight and constitute the most ergonomic actions in the air.

In order to control the aircraft it is essential to know the current flight parameters, which are presented by the informational model in a formalized form.

This is an aggregate of current flight parameter values organized according to specified rules and procedures and implemented with the aid of specialized display and controls.

When flying in instrument meteorological conditions the IMP is incomplete, since its natural part is missing. Flying the aircraft becomes considerably more complicated.

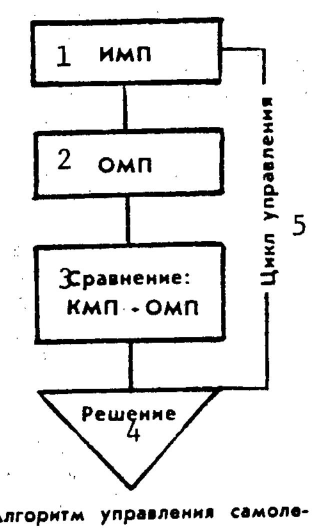
During flight the pilot creates an operational model of flight on the basis of his idea of the aircraft's spatial attitude and displacement.

An operational model of flight is a speculatively formed, short-duration model intended for solving current problems of aircraft control and mission execution. The conceptual model of the transient flight situation developed on the ground is compared via the IMP with the operational model corresponding to the given moment. If the OMP coincides with the KMP, the pilot maintains the aircraft's current attitude and motion. If the OMP differs from the KMP (error signal), a piloting decision is made, on the basis of which control stick actions are programmed. The aircraft's attitude and motion are changed to the desired state. A new OMP is then formed, and it is compared with the KMP corresponding to the current moment of flight. The aircraft control cycle is completed. Flight consists of such activity cycles.

Coordination of information systems with the content of a pilot's mental processes is the most crucial problem of aviation engineering psychology. If the IMP, via the OMP, is in good agreement with the KMP, stable control of the aircraft and flight safety are guaranteed. But if the IMP creates difficulties in forming the OMP and intensive effort is required for comparison with the KMP, the flight will be fraught with the occurrence of hazardous situations. In the final analysis this can lead to a situation where the pilot, with rapid change of flight parameters, will prove unable to create an OMP on the basis of the IMP. And loss of control of the aircraft will be inevitable (see Figure).

Loss of control is a pilot psychophysiological state whereby the pilot, unable to perceive and process instrument-derived information, cannot make a decision on deflection of control surfaces to adjust current flight parameters to conform with the required parameters. The pilot "ceases to think." He either freezes and clutches the controls or proceeds randomly deflecting the control surfaces in different directions. In certain instances loss of control can occur even when the pilot maintains correct spatial orientation.

Aircraft Control Algorithm.



Алгоритм управления самолетом.

Key:
1. IMP
2. OMP
3. Comparison: KMP-OMP
4. Decision
5. Control cycle

Only one term is currently used in aviation terminology—loss of spatial orientation. Loss of control of the aircraft due not to technical but to psychophysiological causes is not considered. Such cases are most frequently classified as loss of spatial orientation. The debate is continuing on what type of artificial horizon should be used on aircraft. But what should be the principal flight instrument in order to ensure stable, reliable control of the aircraft? What should be used to counter the danger of loss of control of the aircraft? These problems are not being addressed at the present time.

Aircraft instrument designers, who sometimes fly along as observers but are not involved in the process of flying the aircraft, are unable to create a KMP and do not create an OMP during flight. They perform during flight only spatial orientation, and therefore, when they propose and defend selection of a given type of display, they try to match it to a spatial attitude image. As a result the direct display offered in presently-existing instruments and instruments under development fails to meet the demands pertaining to maintaining proper spatial orientation, and particularly demands pertaining to safe control of the aircraft in instrument meteorological conditions. But instrument designers are convinced that their technical solutions are the best. That is certainly the case, unless one considers the fact that it is not the airplane that is flying but rather a human pilot controlling the aircraft.

Soviet Helicopter Pilot Killed in Panjshir Valley

91441150i Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 88 (signed to press 4 Nov 88) pp 26-27

[Article, published under the heading "We Are Internationalists," by Maj V. Kazak: "'Take Sadokhin as Wingman'"]

[Text] **Prior to departure I decided to determine just where this little village with such an unusual name for the Volga steppes—Okean [Ocean]—was located! I looked for it on the map for quite some time but could not find it. My trip there with Hero of the Soviet Union Maj Gen Avn Vitaliy Yegorovich Pavlov had been arranged in advance. He had stated the exact day and departure time, and only much later did I realize why the date 25 May had been chosen.... The spring high waters seemed to have flooded the entire area. A tiny little village huddled forlornly on a tiny patch of land which had the appearance of a little island in the middle of the ocean. This was the reason for the village's name. His comrade in arms, squadron deputy commander for political affairs Capt Aleksandr Sadokhin, bearer of the Order of Lenin and the Order of the Red Star, an excellent pilot, loyal comrade, and genuine officer-Communist, hailed from this village.**

* * *

From the reminiscences of Maj Gen Avn V. Pavlov: "It was like any normal airport. Airplanes and helicopters were landing and taking off, and departing passengers were bustling about. But there were no people seeing them off, no women or children, no flowers—it was a military airbase in Afghanistan. Chief of staff officer Antonyshev and I were there to greet new personnel arriving from the Soviet Union.

"Two pilots came up to me.

"'Squadron deputy commander Captain Surtsukov,' one of them identified himself (he is now a lieutenant colonel). 'This is our commissar, Captain Sadokhin.'

"As I greeted the officers I could not help but entertain the thought that soon I might be flying on combat missions with these pilots. But were they prepared for the job at hand, and were they capable of leading their men? I commented that the lofty title of commissar had to be earned.

"'I shall be worthy, Comrade Colonel,' replied Sadokhin. He spoke these words quietly, but with such firmness that I could not help but peer more intently into his eyes. A look of candor, a slightly smiling, uncomplicated countenance. This officer was the kind of fellow you liked immediately. I thought to myself: 'The men will follow such an officer....'"

The village of Okean was visible through the window. The helicopter circled and proceeded to shoot a landing approach just beyond the edge of the village. There was a gentle bump. The main rotor blades began winding down. A slightly-hunched man was approaching, followed at some distance by fellow villagers and a gang of curious boys, who always seem to show up.

"Sadokhin," the kolkhoz farmer introduced himself, extending his hand in greeting.

Aleksandr's father. He later learned that Konstantin Petrovich had seen action from Orel to Prague during the Great Patriotic War, and that he had been wounded. He was in Port Arthur when the war ended. Was it not in his father's stories and in the shine of his Medal of Valor and Distinguished Service Medal that the young lad learned love for the homeland and hatred toward its enemies? It was apparently from his lips that Sasha first heard that terrible word "war," learned what it means to have friends cut down by enemy bullets, and understood what it means for people to be waiting for you at home. This is perhaps true. But I am also sure that he learned to value comradeship and friendship at the Chapayev boarding school, which he attended prior to enrolling at the Syzran Higher Military Aviation School for Pilots. But when did his dream of becoming a combat pilot commence?

Konstantin Petrovich Sadokhin relates: "We had four children. We have three left. The girls of course hung around their mother. But my boys.... Tell me this, daddy, show me that, daddy. Tolya and Sasha are very much alike. They are just a year apart. They loved horses. Abd of course they liked to fish—there is so much water around.... They had lots of ideas about what they wanted to be when they grew up! But as soon as they got a little older the older brother said he wanted to become a sailor. The younger boy wanted to be a pilot. At first I thought it was just children's fantasies and would pass. But no. Anatoliy enrolled in merchant marine school, but things were a little more difficult with Sasha. He was not accepted the first time around. He did not even take the entrance exams. He was told that he was a bit young. He became upset, and even cried....

"Well, what are you going to do if you are too young? He got a job as a lathe operator at the Kuybyshevkabel [Kuybyshev Cable] Plant. I figured Sashka would learn the ropes down at the plant and would become a workingman. But he would not give up his dream of becoming a pilot, and that was that! And he made it! He got accepted in school and graduated. Flying came to him real easy. Yes, he loved what he was doing."

...It seemed that the entire village accompanied us from the helicopter landing site to the Sadokhins' house. And it was a good-sized village: 35 households. The women, seeing the general and the wreath with the inscription "To Aleksandr Sadokhin from his comrades in arms," sobbing, wiped their eyes with the corners of their kerchiefs and aprons. The men stood at attention in the military manner....

Sasha's mother, Nina Illarionovna, was standing on the porch. She ran up to the general and burst into uncontrollable tears. She begged him silently, with tear-stained gaze: tell me, my son, about Sasha....

From the reminiscences of Maj Gen Avn V. Pavlov: "A report came in late one evening in November: an Afghan subunit was heavily engaged in the province of Ghazni. There were wounded. They were urgently in need of medivac assistance. I decided on the spot that we would take two helicopters.

"'Sir,' Capt Anatoliy Surtsukov's voice, always clear and cheerful, was a bit hoarse and contained a note of alarm, 'it's a very difficult situation. It is night, and there is cloud cover in the mountains. Take Sasha Sadokhin as your wingman. He knows the area well.'

"The deputy commander for political affairs and I stood on the helicopter flight line, discussing our flight plan and emergency procedures. As soon as the doctors arrived, we took off.

"As we approached our presumed landing site, I spotted reddish-yellow flashes down below. Mortars were firing. The darkness was pierced by whitish-blue machinegun tracer streams.

"There were a lot of wounded. Sadokhin quickly organized loading of casualties, and within a few minutes we were ready to take off. But at that moment, listening to the cacophony of battle, neither I nor the deputy commander for political affairs realized that the most difficult part of the mission awaited us on the return flight....

"We took off without lights. The flight technician [crew chief] went back into the cabin. He soon reported over the intercom: 'They've got a gravely-wounded soldier on an IV setup. The doctors need light. They ask that you not bank steeply.'

"I was well aware of what this meant. We would soon be out of the clouds, entering a 'window.' If we were lit up, we would be clearly visible from the ground, becoming a good target....

"Sadokhin was the first to spot the danger. 'Skipper, machinegun! A stream of tracer passed under us!' his alarmed voice came over the radio.

"I saw the next burst. It passed ahead and slightly above us. There would soon be another burst....

"'101, two machineguns firing! They are bracketing us. Extinguish cabin light. Establish climb and head away from here! I'll cover!' the deputy commander for political affairs shouted over the radio, and at this point I felt a burst strike the helicopter.

"As a I broke away I noted that Sadokhin's helicopter was positioned below my altitude and was proceeding at high speed in a banked attitude. He was showing all his lights: rotating beacon, navigation lights, formation lights, and landing light.... It was plummeting groundward like a large, lit-up meteorite.

"'He's bought it! He assumed the whole job, providing cover,' the thought flashed through my mind.

"'Skipper!' I heard Sadokhin's voice in my headset. 'Instruments operating normally. I am taking position in formation!'

"There is no room for sentiment in the air, especially when there are wounded on board. Only later, in Kabul, after I gave some more thought to the flight, I realized that in covering me, his commanding officer, Aleksandr Sadokhin had performed a genuine feat of valor.

"But in the meantime we were heading back toward the airbase. The Soviet doctor on board joined the list of wounded Afghan soldiers: he had taken a mujahideen bullet...."

...It was clean and comfortable in the cottage. It smelled like dried grass, kvass, and dried fish. A large portrait of Sasha hung over a sofa. Captain's shoulderboards, an emblem indicating completion of service school, and the wings of a military pilot 1st class. But there are no decorations in the photograph: Captain Sadokhin had not yet been decorated....

The cemetery was close by, in a wooded plot. We walked in silence. Nina Illarionovna and General Pavlov led the procession, followed by Konstantin Petrovich. The other villagers brought up the rear.

Nina Illarionovna Sadokhina relates: "Sashenka loved our Okean, although he rarely spent time here. He was away at boarding school for several years, followed by four years at service school. And that was followed by active military service. But when he did come home on a visit, he could not get enough of our fresh air. He would help his father in the fields, and he would spend time fishing. He often walked along this path. He also liked to sing. His favority song was 'Hope'. It's about home....

"Sasha promised to come home on leave in August, but he came in May instead. I asked him why he had come earlier. He smiled and replied, 'I missed you, Mom.' It was only later that I learned that he had been given leave before heading for Afghanistan. He didn't say that he was about to go there. He kept talking about how he wanted to enroll at the academy....

"Here is a letter we recently received from his younger boy, Kostik. He writes that he wants to be a pilot, just like his father. His older boy, Zhenya, is finishing 6th grade. He doesn't say anything, but one senses that he also wants to be a pilot. They can carry on for their father...."

Major General of Aviation Pavlov silently placed the wreath and saluted, his hand touching the blue band of his service hat, paying his final respects. What was he thinking about at this moment? Perhaps he was recalling the sky over Afghanistan and Aleksandr's last mission.

From the reminiscences of Maj Gen Avn V. Pavlov: "I have bitter memories connected with the village of Barankheil in the Panjshir Valley. I had a squadron commander's helicopter shot down there. The crew was killed, and the wingman's helicopter sustained damage. Wounded Captain Shipunov managed by some miracle to nurse it back to base. Captain Sadokhin was killed near the village of Barankheil.

"...The helicopters, flying at extremely low altitude, darted into the gorge so unexpectedly that the mujahideen did not have time to fire off a single round. After landing and disgorging a subunit of Afghan assault troopers, the helicopters proceeded to take off. At this point the craft came under fire. They picked up some bullet holes. Suddenly an antiaircraft gun began firing at them from the mountain slope past which they were flying. The helicopter being flown by the element leader, Maj Yu. Grudinkin, seemed to hesitate and then proceeded to descend steeply. Streams of tracer lashed out toward it. Sadokhin's helicopter was closest to the rebel weapon position. He noticed that it was well fortified. Positioned on a rock ledge, which was surrounded by granite on all sides, the mujahideen were as if in a tunnel. They could not be hit from the side—only head-on.

"And he turned toward the fire.... If he had not done so, others could have perished.... Streams of machinegun tracer intersected, rising and falling in a searching pattern. The nose glazing was splintered by a direct hit. But the intrepid pilot continued boring ahead. He fired rockets. He watched long enough to note that the rockets were heading precisely for the target. He did not wait to observe the bursts, because it was more important to find out where the element leader had landed and to determine his status, in order to come to his aid. At this moment a heavy machinegun began firing from another ambush position, putting a burst right through the helicopter. Sadokhin winced and slumped forward. He managed to instruct his copilot: 'Rescue the element leader.' Some did not return to base alive that day. Aleksandr Sadokhin was one of those who perished."

...We were leaving Okean. Churning the cloud droplets, the rotor blades cut into the rain-filled sky with a piercing whistle. From time to time the trim mechanism would click in, reducing pressure on the controls. I could not help but wonder how the burden weighing on General Pavlov's heart could be removed, and how Aleksandr's family could be consoled. There was no way. The memory and the bitter feeling of irrecoverable loss remains. By his deed Aleksandr Sadokhin took the burden of danger from our shoulders onto his own, saving the lives of his comrades in arms.

Campaign to Combat Disciplinary Infractions Lauded

91441150j Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 88 (signed to press 4 Nov 88) pp 28-29

[Article, published under the heading "The Army's Strength Lies in Discipline," by Col N. Miroshnichenko, political section chief, Orenburg Higher Military Aviation School for Pilots: "Regulations Must Be Obeyed by All"]

[Text] **Progress achieved implementing the party Central Committee decree calling for strengthening military discipline in the Soviet Army and Navy was analyzed at a meeting of the CPSU Central Committee held on 13 October 1988. The CPSU Central Committee instructed that a number of additional measures be adopted pertaining to strengthening military discipline. At the**

meeting it was noted in particular that leader-Communists, staff personnel, political agencies and party organizations are called upon to ensure rigorous observance of regulations in every unit and subunit and to work more aggressively to improve direction and leadership of military personnel. It is also essential to increase the effectiveness of all forms of indoctrination work and to ensure a radical turn by such work toward personnel.

The following article discusses how these party demands are being implemented.

* * *

Military discipline and organization.... Today the most serious attention is being devoted to these items. The experience of the command element, party and Komsomol organizations of the Air Force training regiment in which Lt Col A. Kryukov serves as deputy commander for political affairs indicates that the task of instilling in personnel respect for military regulations and an endeavor in all things to follow the spirit and letter of the law and to achieve firm observance of regulations in the unit is realistic, and therefore is achievable.

For more than 4 years now there have been no accidents or criminal offenses in this regiment. There has also been a substantial decrease in the number of gross violations of military discipline. Matters pertaining to cadet training and ensuring flight safety are now being better handled in large measure thanks to this. The exemplariness of the unit's party members in conduct on and off duty has improved.

The regiment has maintained its vanguard position in socialist competition performance. Two air squadrons, half of the flights and aircrews, and approximately 60 percent of the servicing and maintenance groups have earned or confirmed the title of excellent.

We should note that these are not those "inflated" figures which in the not so distant past reflected rather the desired than the actual level of combat training, professional skill, discipline and esprit de corps of Air Forces personnel.

Combat improvement and flight training results achieved as of the present time are a logical consequence of smooth, close-knit efforts on the part of commanders, political workers, party and Komsomol organizations in accomplishing the tasks of training flight personnel, increasing the flying proficiency of instructors and student pilots, ensuring flight safety, and maintaining proper military procedure and observance of regulations in the unit.

Developing in Air Forces personnel a conscious need to measure up to the demands of the military oath of allegiance and military regulations in their daily lives and service activities occupies a central place within the aggregate of organizational and political measures conducted in the regiment pertaining to strengthening military discipline. The practical thrust of all ideological-political measures is being strengthened. In instruction classes within the system of officer Marxist-Leninist training, political training of warrant officers, and political instructions classes with NCOs and primary-rank enlisted personnel, we find time for frank discussion and critical analysis of the performance of the personnel of squadrons or flights, as well as individual Air Force personnel pertaining to ensuring orderly procedure in one's assigned duties as well as discussion of unresolved problems, deficiencies, and ways to correct them.

Demonstration classes, briefings, and exchange of work experience and know-how are extensively employed to give practical assistance to officers in mastering the method of combined approach to training and indoctrinating subordinates.

The principle of "superior teaches subordinate" is becoming a determining factor in the activities of regiment and squadron leader-Communists in teaching subordinate command personnel, political workers, party and Komsomol activists the practical skills of strengthening military discipline, dissemination and consolidation of the demands of the military oath and regulations, as well as work with individuals.

Emphasis is placed on improving the methodological proficiency of leader personnel of all categories. There is a reason for all this. Experience indicates that reasons for a poor discipline situation include poor knowledge of the provisions and requirements of military regulations on the part of officers, warrant officers, and noncommissioned officers, a lack of knowledge and competence in explaining and publicizing them, and voluntarism in one's actions, especially in disciplinary practice. The people in this regiment believe that it is important to put an end to such phenomena as quickly as possible.

The unit's party organizations are doing a great deal of work, together with commanders and political workers, to achieve a radical turning point in the state of military discipline. In their work they are guided by the decisions of the 19th All-Union CPSU Conference. The party committee of which party member V. Dorokhov is a member, as well as the headquarters and squadron party organizations are concentrating efforts on ensuring personal exemplariness on the part of party members in performance of job duties, in training and discipline, and on enhancing their role in and influence on strengthening orderly procedure and organization. These matters are regularly discussed at party meetings at the regimental level, at meetings of the party committee, and in the party collectives of the squadrons and flights.

The party committee examines the activities of the party organizations of the subunits, assists them in working to strengthen military discipline, and seeks to ensure that each and every party organization performs in a practical

manner its role of political nucleus of the military unit and displays activeness and aggressiveness in establishing an atmosphere of mutual demandingness, integrity, and proper observance of regulations.

One current task to the accomplishment of which great importance is attached by the unit command element and party organization is every possible enhancement of the role of the community in strengthening discipline and orderly procedure. They regularly hold general meetings of military personnel, question-and-answer evenings, they pay attention to complaints, requests, and suggestions by military personnel and the members of their families, and they check to make sure adopted measures have been carried out. It has become regular procedure that prior to the commencement of meetings and question-and-answer evenings, their organizers brief personnel on the status of requests received at the previous get-together between regimental or squadron leaders and personnel.

The young officers council headed by Maj V. Ivanov and the women's council and its chairman, N. Lugova, are actively involved in indoctrination efforts and in creating a favorable moral-ethical microclimate in the unit and in the Air Force garrison. Working together with the command element, party committee, and Komsomol committee, they are doing a great deal to improve personnel leisure time activities and to acquaint newly-arriving officers and their wives with the traditions of the unit, and they are helping their colleagues settle in at their new duty post.

The officers' and warrant officers' comrades' courts of honor are also changing their work style and methods.

Giving good advice, helping a comrade in a practical manner, analyzing the causes of infractions of the law, and when necessary punishing the guilty parties—these activities are increasingly taking the forefront in preventive efforts by the comrades' court of honor presided over by Lt Col A. Lakovich. The effectiveness of such an approach is obvious. At one time Lakovich and his assistants had to put out a great deal of effort to return officers M. Kulagin, L. Nudnenko, and others to the straight and narrow, who were inclined to break regulations during the performance of their duties. Using persuasion for the most part, and compulsion when necessary, the activists succeeded in making these Air Forces personnel change their conduct and attitude toward performance of duty.

Strengthening of discipline, organization and orderly procedure in the regiment is inseparably linked with efforts to increase flight safety. Incidentally, the regiment has gone 29 years now without any fatal accidents or other air mishaps. While not downplaying the importance of collective forms of indoctrinational influence, recently emphasis has been increasingly placed on work with individuals.

An analysis conducted in this unit of air near-mishap incidents through the fault of personnel occurring over the course of the last 5 years indicated that those officers who are not thoroughly familiar with regulations and procedures have problems in the air. Maj Yu. Fedosov, for example, who had four disciplinary infractions on his record, was responsible for six near-mishap incidents, while Maj N. Letov, with six disciplinary infractions on his record, was responsible for five near-mishap incidents.

In order to eradicate such a "pattern" from Air Force personnel practical combat training and performance of duties, all officers and warrant officers who are inclined toward infractions of military, flight, and job discipline have been placed under special scrutiny by the regimental command element, party committee, and primary party organizations. This scrutiny presupposes first and foremost active, purposeful indoctrinational effort on the men. The purpose is to make each and every member of the military thoroughly aware of the need for discipline and orderly procedure as one of the decisive conditions for the success of perestroyka, further increase in the combat readiness of the unit and subunits, and the foundation of professional respect.

An example in this regard is provided by Capt P. Bogachev, who some time back was made deputy commander of an air squadron. A high degree of flying proficiency, inner composure and discipline, and excellent knowledge of the aircraft helped him emerge victorious from a difficult situation. His aircraft experienced an engine failure on takeoff, at a height of 15 meters. The pilot lept his composure and continued on his one good engine. He gained additional altitude, came around, and landed safely. Incidentally, this was the first such incident of its kind with the type of aircraft in question.

One can judge from the following facts the effectiveness of the indoctrinational efforts of the regiment's command personnel, party organizations, and the community at large. During the winter period of training the year before last, five officers committed gross violations of regulations, while the number dropped to three for the first six months of last year, and to one for the first six months of this year. Changes for the better have occurred, although it would certainly be premature to rest on their laurels.

Some might ask: so what's new? These areas of emphasis in effort are well known, and so are the forms employed. This is true. They are not inventing any unusual new techniques in the unit, although they are searching for and finding new approaches. They are applying effectively that which has been recommended and has withstood the practical test. But the secret of success lies in the following: this work is not being done sporadically, not just when an infraction has taken place, but on a regular basis and in a thoughtful manner, without a lip-service approach. We believe that such an approach to the problem is fully in conformity with the spirit of

perestroyka. And practical experience confirms a simple truth, to which we unfortunately sometimes shut our eyes and which sounded with renewed emphasis at the 19th All-Union Conference: it is not words and appeals which get results, but rather specific, purposeful effort. This is precisely how they are proceeding in this regiment.

Efficient Scheduling of Flight Operations

91441150k Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 88 (signed to press 4 Nov 88) pp 30-32

[Article, published under the heading "Implementing the Decisions of the 19th All-Union CPSU Conference," by Maj Gen Avn Professor V. Pisarev, doctor of technical sciences: "Flying Time: Effectiveness and Quality"]

[Text]

"All defense organizational development," notes the Resolution of the 19th All-Union CPSU Conference, "should henceforth be focused primarily on qualitative parameters -- both as regards equipment, military science, and the composition of the armed forces." This party guideline, which is based on principle and integrity, finds expression in the concrete actions of military aviation personnel. Working to achieve high results for each and every flight operations shift, they are endeavoring to utilize training time in the most efficient manner and substantially to increase the effectiveness of utilization of aircraft and to increase the flying time logged by each aircrew.

* * *

Increasing the amount of flying time per flight operations shift is an important factor in intensification of air combat training. The precious time which is saved in the process makes it possible to improve the quality of preliminary preparations for flight operations as well as the effectiveness of scheduled work on the aircraft, which unquestionably affects the quality of performance of flight assignments and flight safety.

How can reserve capability be found in a line unit to increase personnel work efficiency? For this it is necessary first of all to utilize the principal mechanisms which affect aircraft utilization during a flight operations shift. These mechanisms were discussed in an article entitled "Flying Time and Flight Hours

Logged" (AVIATSIYA I KOSMONAVTIKA, No 6, 1978). Visits to line units, however, indicate to us that these recommendations are not being utilized fully enough at the present time.

Principal criteria for estimating efficiency of aircraft utilization include the coefficient $K_н$, which is determined by the number of flight hours logged during a flight operations shift. The complete formula is as follows:

$$T = K_н n t_c, \qquad (1)$$

where T is flying time logged during a flight operations shift; n is the number of aircraft scheduled for flight operations (not including standby equipment); t_c is the duration of actual flying time.

The formula shows a direct relationship between total flying time and number of aircraft n, which is determined by the training missions being performed by the unit, by the duration of total flying time t_c, and coefficient of aircraft utilization during flying time $K_н$.

Practical experience has established that $K_н$ changes from zero (when flight operations are cancelled) to 0.75. It is also possible that $K_н = 1$ if a flight operations shift begins with launching all departure-ready aircraft and ends after they land. Such an organization of flight operations, however, cannot ensure required achievement of the plan target involving training aircrews by type of flight operations. In vanguard line units, however, they skillfully utilize reserve capability and achieve a high coefficient of aircraft utilization. It was established on the basis of analysis of experimental data that, with an increase in duration of actual flying time to 4-5 hours, the value of the aircraft utilization coefficient, decreasing smoothly from 1, reaches some stable value. A further increase in actual flying time does not produce significant improvement but merely increases duration of the flight operations shift.

The stable value of the aircraft utilization coefficient in relation to average duration of flight of a single aircraft $\overline{t}_{пол}$ and its average time on the ground $\overline{t}_{зем}$ is determined by a formula which is valid for aircraft of any type:

$$K_{и} = \overline{t}_{пол}/(\overline{t}_{пол} + \overline{t}_{зем}). \qquad (2)$$

It is evident from the formula that in order to increase efficiency of aircraft utilization it is necessary to increase average flying time and to decrease aircraft time on the ground.

An increase in time in the air is provided by full utilization of an aircraft's technical capabilities and is achieved in the units by combining flight tasks (maneuver sequences). One should also correctly determine the necessary fuel reserve. Fuel reserve, depending on aircrew proficiency, should ensure both flight safety and economical fuel consumption. Otherwise, as was determined from flight data in a certain Air Force unit, enough fuel is expended on hauling excessive fuel in an aircraft's tanks over the course of 10 sorties to fuel an additional (11th) sortie if the correctly-determined fuel reserve is carried.

The average time an aircraft spends on the ground $\overline{t}_{зем}$ is determined by its design features and organization of personnel work activities during a flight operations shift. It can be determined with the following formula:

$$\overline{t}_{зем} = \overline{t}_{нт} + \overline{t}_{выр} + \overline{t}_{зар} + \overline{t}_{лэ} + \overline{t}_{нс}, \qquad (3)$$

where $\overline{t}_{нт}$ is the least time required to turn around a single aircraft (it is determined by an aircraft's designed-in efficiency of servicing and maintenance and depends on the number of groundcrew personnel working on it. The greater the number of ground personnel, taking into consideration the degree to which they can work on the aircraft simultaneously and the availability of all required servicing

and maintenance equipment, the shorter the overall turnaround time);

$\overline{t}_{выр}$ -- average aircraft taxi-out time to active;

$\overline{t}_{зар}$ -- average aircraft taxi-in time from active to aircraft refueling and rearming area;

$\overline{t}_{лэ}$ -- aircraft idle time due to absence of aircrew;

$\overline{t}_{нс}$ -- aircraft idle time due to poor organization of work procedures, connected with lack of aviation engineer service personnel or servicing and equipment when needed.

During conduct of experimental organization of flight operations and examination of a flight operations shift model, values $\overline{t}_{лэ}$ and $\overline{t}_{нс}$ were determined on computers. On the basis of simulation of aircraft flight and ground turnaround, all quantities needed for computation were entered into the computer and quantitative relations between them were determined. Processed experimental data from vanguard line units together with data obtained from modeling a flight operations shift are contained in Figure 1. It is expedient to use these figures in planning and scheduling flight operations. To accomplish optimum results, it is essential to provide the following in the Air Force unit: precise, prompt, rapid transmission of instructions via communications equipment to personnel working on aircraft, which will make it possible to avoid aircraft standing idle on the ground due to poor work organization; assignment of aircrews to each aircraft, which immediately takes off when it is departure-ready; determination of the number of so-called standard aircraft servicing teams (URBP).

With this method it is very important directly to determine the number of URBP which are equivalent in capabilities to the personnel assigned to the flight operations. We shall discuss this in greater detail. The URBP is called standard because the ground personnel and equipment it represents are not integrated

into a single subunit but work jointly (simultaneously or sequentially) only when preflighting an aircraft or turning an aircraft around. The team is called "raschetnaya" because it is used to determine the possible value of $K_и$, and also because a single URBP, working on a single aircraft, will ready it for flight within an average work-process time, which is less than the average aircraft time on ground determined on the basis of experimental data.

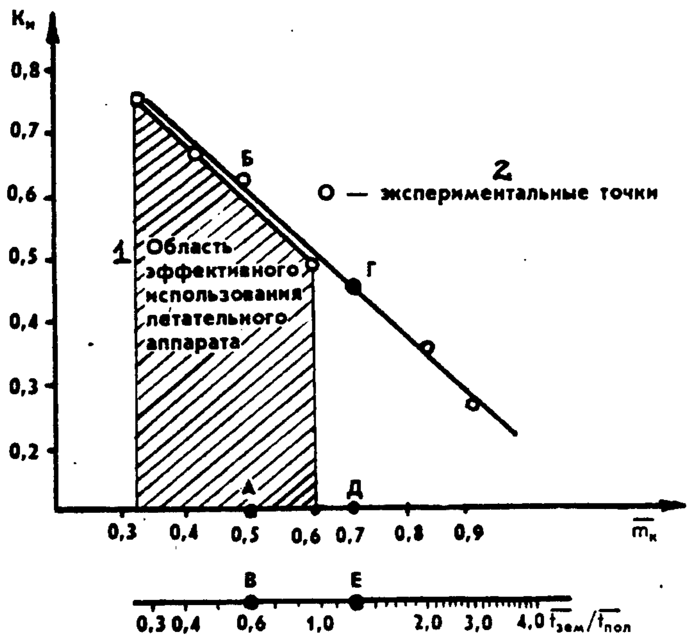


Figure 1. Relationship Between the Greatest Stable Value of Aircraft Utilization Coefficient and Relative Number of Standard Servicing Teams Ensuring That This Coefficient Is Achieved, and Ratio of Average Aircraft Time on the Ground and in the Air

Key: 1. Region of efficient aircraft utilization; 2. Experimentally-derived figures

Average process time to turn a single aircraft around, $\overline{t_T}$, is determined on the basis of available personnel and TOE ground servicing equipment. But the standard value for average least process time $\overline{t_{HT}}$ is determined with the condition of technically possible organization of servicing procedures on the aircraft whereby this time proves to be minimum for the given preflighting variation. Of course in this case a mandatory condition is availability during flight operations of a sufficient quantity of all aviation engineer service personnel and equipment required to perform preflighting and turnaround. A number of URBP m_0 can be formed of these personnel and this equipment, each of which will preflight/turn around an aircraft in least process time $\overline{t_{HT}}$.

An URBP contains two groups of ground personnel. The first, including groundcrews, is assigned to each aircraft and does not influence the total number of URBP operating during flight operations. If they alone estimated the number m of URBP, it would always be equal to number n of flying aircraft (m=n), or half of that number (m=0.5n) if two aircraft are assigned to each groundcrew.

The second part of the URBP consists of ground maintenance personnel and equipment not assigned to a specific aircraft but which perform work on it. The availability of precisely this personnel and equipment affects the average aircraft turnaround process time. The fewer there are working during a flight operations shift, the greater will be average process time $\overline{t_T}$, but it should certainly be less than $\overline{t_{3eM}}$ obtained with formula (3) or from the graph in Figure 1. Increase in $\overline{t_T}$ should certainly be accompanied by an increase in the number of URBP used for calculations. The number of teams will be the smallest with $\overline{t_{HT}}$ (equal to m_0).

We should note that a portion of the equipment, such as gas charging units (GZS), can be operated in common by several URBP. One GZS, for example, is sufficient for simultaneous operation of nine URBP, if $\overline{t_T} = \overline{t_{HT}} =$ 28 minutes, while charging time is 2 minutes and

transfer time is 1 minute. Thus the number of URBP, depending on the possible average process time, can vary with the same quantity of various component equipment.

If there is a sufficient number of ground maintenance personnel and equipment available during flight operations, the number of URBP may be equal to the number of flying aircraft $m_n = n$, while $\overline{t}_{нс} = 0$, that is, in this case there should be no aircraft idle time due to the lack of any aviation engineer service servicing personnel or equipment when needed. Experience indicates that in order to obtain a high aircraft utilization coefficient value the number of URBP can be less than the number of aircraft. The greatest possible $K_и$ value can be obtained with an efficient ratio of URBP to aircraft:

$$\overline{m}_к = m_к/n.$$

The relative number of URBP and the aircraft utilization coefficient obtained in this instance are linked by the following relation:

$$\overline{m}_к = 1,13 - K_и,$$

where $\overline{m}_к$ is a reasonable ratio of the number $m_к$ of URBP and n aircraft, which ensures a maximum stable utilization coefficient value of 0.17 equal to or less than $K_и$ equal to or less than 0.75 with a given value of $\overline{t}_{зем}$ and $\overline{t}_{пол}$: $\overline{m}_о \leqslant m_к \leqslant 0,96.$

Figure 1 contains a graph of this relationship. As is evident from the graph, the region to the left of line ABC is characterized by the fact that the number of URBP is less than half of the number of aircraft allocated for flight operations. It is precisely in this region that one can schedule for one URBP to turn around two aircraft, that is, one groundcrew forming part of an URBP would be assigned two flying aircraft, which happens to be prescribed

by regulations. This possibility is due to the fact that average aircraft time on ground (to the left of line ABC), equal to $\overline{t}_{зем} \leqslant 0{,}6\ \overline{t}_{пол}$, proves to be less than flight time, and an URBP can continuously turn aircraft around without significant aircraft idle time.

The graph in Figure 1 and the formulas (1-5) make it possible to calculate in the line unit the required quantity of assets to ensure efficient aircraft utilization during a flight operations shift.

Let us consider an example of such a calculation. The schedule calls for flight operations out of a field strip over the course of a 5-hour flight operations shift. The flight operations organizer has at his disposal an adequate quantity of all requisite manpower and assets, but he has only three fuel trucks. Let us assume that the scheduled average sortie duration is $\overline{t}_{пол}$ =67 minutes, while the least aircraft time on ground $\overline{t}_{зем}$ =38 minutes with $\overline{t}_{кт}$ =28 minutes when turnaround procedures are performed by a single URBP. We want to assign to flight operations that specific number of aircraft whereby efficiency of utilization of each aircraft will be maximal.

Here is the calculation sequence. We determine the number m_0 of URBP. A single fuel truck can fuel two aircraft in 26 minutes. Fueling one aircraft and bringing the truck to it requires 13 minutes (Figure 2). In this instance the number of URBP will be determined by the product of m_0 = 2x3 = 6. We use formula (2) to obtain $K_и$ = 67/(67+38) = 0.64, and we obtain from equation (5) relative number of URBP $\overline{m}_0$ = 1.13- $K_и$ = 1.13-0.64 = 0.49. For $\overline{m}_0$ = 0.49 and m_0 = 6, using formula (4) we obtain n = 6/0.49 = 12.2 equal to or approximately equal to 12. Consequently, 12 aircraft must be scheduled for flight operations. We refine our calculation taking into consideration current rounding off procedures.

We find $\overline{m}_к = \overline{m}_0$ = 6/12 = 0.5. and then. using formula (5), $K_и$ = 1.13-0.5 = 0.63

and, using formula (2),

$$\overline{t}_{зем} = \frac{\overline{t}_{пол}}{K_{и}} - \overline{t}_{пол}$$ =39.3 minutes,

points A, B, C (Figure 1). In view of the fact that the resulting aircraft on-ground time (39.3 minutes) exceeds the minimum aircraft on-ground process time (28 minutes), the 12 aircraft scheduled for sorties can be turned around by six URBP. This ensures the capability to obtain the scheduled numbers both in terms of overall flying time T = 0.63x12x5 = 37.8 hours, as well as flying time per aircraft and per pilot if their numbers are equal, 0.63x5 = 3.2. Each flies an average of 0.63 hours per hour of actual flying time.

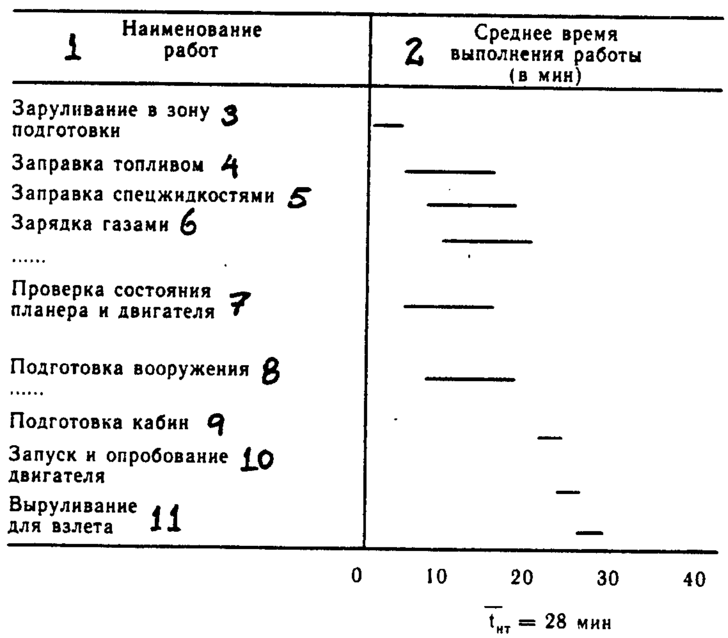


Figure 2. Elements of Aircraft Turnaround Process Schedule

Key: 1. Procedure; 2. Average time to perform procedure (minutes); 3. Taxiing to ramp area where refueling/rearming are performed; 4. Fueling; 5. Replenishing aircraft fluids; 6.

(Key to Figure 2, continued) Recharging compressed gases; 7. Inspection of airframe and powerplant; 8. Rearming; 9. Cockpit/Flight Deck/Crew Cabin preparation; 10. Engine start and runup; 11. Taxiing to the active

---

Let us examine another flight operations shift schedule variation. Let us assume that, wishing to obtain greater actual flying time, six more aircraft were assigned to flight operations, but the other conditions remain unchanged. What will the results be? Since according to the stipulated condition aircraft turnaround is limited only by fuel trucks, we shall determine a new number of URBP according to the number of fuel trucks. For this we find the ratio between the possible average per-aircraft turnaround time and the number of possible refuelings during this time. Under the new conditions the average turnaround process time will increase, since there will be an aircraft turnaround idle time of $\overline{t}_{nc} \neq 0$.

Let us assume that a fuel truck can fuel three aircraft during this time. The process time for them will then be 3x13 = 39 minutes, while on-ground time will be not less than 39+6+4 = 49 minutes. The number of URBP is determined by product m_1 = 3x3 = 9. Consequently, $\overline{m}_1$ = 9/18 = 0.5, while K_n will be 0.63. These figures can be achieved with $\overline{t}_{sen}$ = 39.3 minutes, which is less than reference time (49 minutes), and therefore it cannot be achieved when m_1 = 9. We shall repeat this calculation, increasing the number of aircraft sequentially fueled by a single fuel truck. With four aircraft we have: 4x13 = 52 minutes, while $\overline{t}_{sen}$ = 52+6+4 = 62 minutes, m_2 = 4x3 =12, $\overline{m}_2$ = 12/18 = 0.67 using formula (5), K_n = 0.46, and, using formula (2), $\overline{t}_{sen}$ = 78.7 minutes, points D, E, F in Figure 1. This time is greater than reference time, and therefore can be achieved when $m_2 = 12$.

Consequently, when assigning 18 aircraft to flight operations, with three fuel trucks, we must use the figure of 12 URBP instead of six. This can ensure actual flying time during a flight operations shift T = 0.46x18x5 = 41.4

hours. Each pilot flies 0.46x5 = 2.3 hours or 0.46 hour per hour of flying time within the flight operations shift.

Comparison of these two variations enables us to conclude that with three fuel trucks it is better to schedule flight operations for 12 aircraft than for 18. Flying time per pilot will be greater, and efficiency of aircraft utilization increases, with $K_{и} = 0.63$ instead of 0.46.

Conclusion. If for various reasons a unit has a limited number of various aviation engineer service personnel or servicing equipment, the possible quantitative formation of URBP for flight operations must be determined on the basis of available personnel and equipment, after which one determines the ratio $m_{и}/n$ ratio, and with this quantity determines the number of aircraft assigned to flight operations and, consequently, the number of aircrews. Only under these conditions can we ensure high-intensity utilization of aircraft during flight operations shifts and efficient expenditure of personnel work time per actual flying hour.

Thus in order to increase the labor efficiency of air unit and subunit personnel it is most expedient first of all to resolve the problem of increasing the efficiency of aircraft utilization during a flight operations shift. Herein lies the guarantee of success. Figure 1 contains the region of maximum efficient aircraft utilization, where an aircraft is in the air for more than 30 minutes of every hour of flight operations. This requires availability of a sufficient number of aviation engineer service personnel and a sufficient quantity of servicing equipment and personnel, capable of turning around a large number of aircraft in the least process time. Incidentally, preparation of a flight operations schedule is also facilitated by such calculations.

We should note that, by utilizing this method, with the prepared flight operations schedule one can easily assess the quality of scheduling

by determining the coefficient of aircraft utilization. For this one divides total flying time (excluding flying time for weather reconnaissance) by the product of the number of aircraft times flight operations time: $K_и = T/n_i t_c$.

Correct, efficient flight operations shift scheduling is a guarantee of success in Air Force unit combat training.

Preventing, Removing Corrosion From Aircraft

91441150l Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 88 (signed to press 4 Nov 88) pp 32-33

[Article, published under the heading "Putting the Recommendations of Science Into Practice," by Lt Col B. Kuzevanov, candidate of technical sciences: "Corrosion: Features of Occurrence and Prevention"]

[Text] Ensuring aircraft reliability is inseparably linked to aircraft anticorrosion protection. This problem has become particularly acute in recent years, when the effect of many environmental factors has become intensified due to pollution of the atmosphere with aggressive substances.

Loss of metal is most frequently named as the principal adverse consequence of corrosion. And yet deterioration of the properties and parameters of complex pieces of equipment causes much worse consequences. In particular the effect of corrosion on structural component fatigue is manifested in the fact that it creates a concentration of stresses and accelerates the development of cracks. In practical aircraft operations there have been instances of parts failing under static loads due to diminished cross section.

Today principal efforts are being directed toward finding new corrosion-resistant materials and development of more effective methods and means of protection against corrosion. But this requires a clear understanding of the physical substance of corrosion and requires the ability to carry out effective protective measures in a prompt and timely manner.

Atmospheric corrosion exerts the greatest effect on aircraft. The mechanism and rate of atmospheric corrosion are determined in large measure by degree of moisture on metal surfaces. Atmospheric corrosion is subdivided into three types according to this criterion: wet (when there is a visible film of moisture on a metal surface); damp (a very thin, invisible film of moisture on a metal surface); dry (no moisture on surface).

Development of atmospheric corrosion depends to a considerable degree on the thickness of the moisture layer on the surface of a metal (alloy). The rate of physical breakdown of parts increases sharply with an increase in moisture layer thickness.

Wet and damp atmospheric corrosion are the most hazardous, since they are based on electrochemical processes, the intensity of occurrence of which is determined chiefly by air moisture and temperature, the presence of aggressive pollutants in the air, and by level of solar radiation. Prompt removal of moisture from aircraft structural surfaces forms the basis of preventive measures.

All other conditions being equal, the rate of atmospheric corrosion increases substantially upon reaching the first critical humidity threshold (70 percent relative humidity), and more rapidly after reaching the second critical threshold (97 percent). The falling of dew signifies exceeding of the second critical humidity threshold for most metals and for this reason significantly accelerates the corrosion process.

The corrosion process also accelerates with a combination of high air temperature and humidity. But high temperature is not the determining factor—often corrosion occurs less in summer than winter. This is due to the fact that as the temperature rises, electrochemical reactions speed up on the one hand, while moisture evaporates more rapidly on the other.

One must bear in mind that when aircraft are redeployed, from Central Asia to the Baltic, for example, old experience in combating corrosion may prove ineffective. Even start-up of a new industrial plant discharging harmful pollutants in the vicinity of an airbase can substantially worsen the situation. Precipitation is particularly dangerous in industrial areas, the air in which contains large quantities of harmful pollutants, since corrosion takes place 4-6 times as rapidly. In some southern regions the use of water containing an elevated quantity of salt (chlorides) for washing aircraft also promotes the onset and accelerated development of corrosion at difficult-to-inspect locations.

High temperature, humidity, and air pollution do not per se exert considerable effect on acceleration of atmospheric corrosion. It is caused by the combined effect of these factors. Solar radiation and wind adversely affect protective materials (paint, anodized coatings, lubricant greases). In hot-climate regions aircraft skin temperature can reach 80-90° C under the effect of the sun's rays, which leads to gradual breakdown of protective coatings, as well as to softening, leakout, blowout, and oxidation of protective lubricant greases. Paint coatings lose luster: chalking (weathering of pigment) occurs. In addition, the wind carries dust and sand, which cause abrasive removal of anticorrosion coatings.

Corrosion breakdown of aircraft assemblies is observed for the most part in enclosed locations (in enclosed spaces, riveted seams, bolted or screw connections), and this is extremely dangerous. Exfoliation or flaking (surface) corrosion is most typical for components made of aluminum alloys. The principal indication of this type of corrosion is bulging of the paint or the metal itself, as well as the presence of a grayish-white film.

Corrosion damage to high-strength alloy structural elements bearing loads and stresses presents considerable hazard. There have been cases of sudden failure of tailfin sternposts, fuselage wing attachments, and landing gear shock struts. Skin flaking along the edges of bolt and rivet holes is no less dangerous. This occurs as a result of intergranular corrosion, which attacks the grain boundaries at the surface of bolt and rivet holes and spreads in a direction parallel to the skin surface. Bulging of the metal also occurs.

The best means of preventing intergranular corrosion is to employ liquid-primer bolting and riveting, which inhibits moisture from entering the gap between rivet (bolt) and hole. It is recommended that this operation be done when performing maintenance on airframe components.

It is essential to perform simple but effective measures on a regular basis in order to prevent corrosion damage (see table).

Table

1. Typical Areas of Corrosion Occurrence on an Aircraft	2. Assessment of Corrosion Damage	3. Preventive Measures
interior surface of enclosed spaces in the wing, tail assembly, fuselage (especially in the lower part);	Determine: location and conditions of occurrence;	thorough inspection of the aircraft;
boundaries between sealed and unsealed parts of the fuselage, where the greatest temperature drop may occur and, as a consequence, elevated condensation of moisture;	type of corrosion damage; presence and condition of anticorrosion coating; area and depth of corrosion;	using protective covers to protect aircraft against atmospheric precipitation, solar radiation, and wind erosion;
points of contact between metal components, hygroscopic materials, liners and gaskets;	possible causes of occurrence;	removal of moisture from possible accumulation locations, prompt drying of wet heat and sound insulation;
points of contact between unlike metals;	effect on condition and status of damaged structural component, need for specific inspections of other aircraft of the same type;	ventilation of aircraft interior spaces to prevent atmospheric moisture;
components made of magnesium alloys;	proposed method and means of correction (prevention);	prompt and timely cleaning out of drain holes serving enclosed areas;
storage battery locations and areas affected by engine exhaust gases;	possibility of continued operation of aircraft.	prevention of mechanical breakdown of protective coatings, prompt recoating;
exterior surface affected by atmospheric precipitation;		removal of dirt, mud, dust, soot, etc from surfaces;

Table

1. Typical Areas of Corrosion Occurrence on an Aircraft	2. Assessment of Corrosion Damage	3. Preventive Measures
unventilated fuselage bays, especially areas with glued or welded stringer-skin connections.		prompt, timely, high-quality relubrication of moving structural components; prompt, timely, and complete removal of spilled battery electrolyte; elimination of poor-quality surface preparation and changes in process of applying protective coatings; elimination of washing aircraft with detergents or other cleansing agents not prescribed by servicing manuals.

When protective-covering a fixed-wing or rotary-wing aircraft, one must bear in mind that air under the cover becomes moisutre-saturated after rain or a heavy dew, and intensity of corrosion processes increases. It is therefore essential to remove and dry out protective covers. They should not contain slits, holes, or sagging areas, in order to prevent the accumulation of moisture.

When inspecting an aircraft one should use magnifying glasses, flashlights, gauges for measuring corrosion depth, fixed-grid templates to determine affected area, and ultrasonic inspection equipment.

In the process of evaluation it is necessary first of all to determine whether damage is a result of mechanical wear, scoring or scratching, or the direct result of corrosion process. This determines the choice of method of correction and prevention of this undesirable phenomenon.

Before applying a protective coating to a metal surface it is necessary to remove corrosion and pollution products. The best method to use in operational conditions is mechanical cleaning using sandpaper, wire brushes, bristle brushes, and scrapers. If the corrosion damage has spread under adjacent elements (bolt heads, nuts, brackets, straps), they should be disassembled. After corrosion products have been removed, cleaned areas must be blown with compressed air and wiped with a gasoline-moistened rag. Paint or lubricant grease should then be applied, and not later than 2 hours after the corrosion has been removed.

Prompt, timely, and high-quality performace of preventive measures makes it possible to eliminate the occurrence of corrosion damage and substantially to improve aircraft operational reliability.

Aircraft Maintenance Depot Streamlines Operations

91441150m Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 88 (signed to press 4 Nov 88) pp 34-35

[Article, published under the heading "Following a Policy of Perestroyka," by Col V. Doroshkov, candidate of technical sciences: "The Dialectic of Action"]

[Text] **All of us must understand well and clearly the inseparable link between changes in people's standard of living and practical efforts at perestroyka. Labor is the basis of wealth, and perestroyka is showing even more clearly the essence and validity of this thesis. Only via perestroyka will we be able to carry out our plans in the domain of social policy, for these plans are grounded on radical changes in the economy and shifting from a path of extensive development to intensification.**

From an address by General Secretary of the CPSU Central Committee M. S. Gorbachev in Krasnoyarsk on 16 September 1988

* * *

The aircraft maintenance depot [aviaremontnoye predpriyatiye (ARP); also may be translated as aircraft overhaul enterprise or aircraft rework facility] had a persisting reputation as a difficult operation when higher military aviation engineering school graduate A. Zhemaytis was assigned to this facility in 1972. It was here that he went through his period of development as an aircraft maintenance specialist, leader, supervisor, and manager. In 1980 Major Zhemaytis was placed in charge of this ARP. Some mistakes were made at first, but both the workforce and the managerial staff gave him assistance and support.

He had inherited a mediocre operation. Physical facilities left much to be desired. The principal and auxiliary shops and sections were housed in buildings which were ill-adapted to their function. Social matters had also been left unresolved for an extended period of time. A

radical restructuring was needed, particularly since the workforce was about to begin mastering depot maintenance procedures on third-generation aircraft.

The young manager fully realized that he could not do it alone. In the process of restructuring, comrades in arms are essential: competent individuals with initiative, who place primary emphasis on getting the job done. Enterprise chief engineer officer Ye. Druzhbin, a party member, became Zhemaytis's first such assistant in all undertakings. It is characteristic that young people: workers, engineers, technicians, and officers—were the first to throw support behind the restructuring of all activities at this aircraft maintenance depot.

The new chief asked himself: "Where shall we begin? How can we get people's enthusiasm, raise their professional pride, arouse in them a sense of proprietorship?" Day after day he performed analysis of hindering factors and sought out reserve potential. He took counsel with the maintenance depot's activists, engineers, and rank-and-file workers.

Many suggestions and proposals were articulated in the course of discussion and debate. This leader-officer grasped that the main thing was to adhere unswervingly to the principle of material incentive in combination with observance of social justice in distribution, for each and every worker has an interest in doing good, high-quality, and duly-appreciated work, as well as in effective participation in production management. Zhemaytis also considered the following factor. A substantial percentage of the blue-collar and white-collar workers were endeavoring to increase their skill level, to master another job area, and to achieve job advancement. It was necessary to utilize all these material and moral instruments in full measure.

Nevertheless the fate of restructuring is determined on the shop floor. Specialist personnel from the enterprise, the directorates and design organization drew up a list of technical-economic observations and drafted a master plan for renovating the facility. Following a process of reconciliation and approval by the appropriate agencies, implementation of the master plan began. More than 20 large facilities have been built and put into operation here over the course of the last two five-year plans and the first years of the current five-year plan, both on a contract basis and using the enterprise's own manpower and equipment.

Replacement and upgrading of equipment was proceeding in parallel with renovation of buildings and structures. All this naturally resulted in a growth in fixed assets, which in turn required that the enterprise manager take steps to stabilize return on capital and to ensure steady growth of capital return. Focusing the workforce on intensification of labor, mechanization and optimization of production processes, adoption of advanced technologies, and more efficient utilization of equipment became the main thrust in these efforts.

Fundamental upgrading and replacement of fixed assets demanded improved efficiency of fixed assets utilization. This problem is being resolved in a comprehensive manner, on the basis of activation of the human factor, particularly by increasing the labor activeness of specialist personnel, the workers in the shops and departments, each and every employee, as well as by increasing the workforce's level of job skills.

A system of production-economics education and skills upgrading is in operation at the ARP. Training facilities are being improved. A computer training classroom has been installed and is in operation. The first group of managers and specialist personnel has completed a course of training, with enlistment of the services of instructors and design engineers from the Engineers' Club [Dom Inzhenerov]. Personal computers as well as Iskra computers are being installed.

All managers, from brigade leader [brigadir] on up, are appointed taking into consideration the opinion of the workforce. Former candidates for job vacancies have been elected to supervisory and executive slots in this manner.

Close attention is being devoted at the ARP to improvement of working conditions and implementation of the basic principle of socialism: "From each according to his abilities, to each according to his labor." Certain positive changes have also been noted in this area as well. All conditions for highly-productive labor have been created in the new buildings. Decent employee facilities with all the amenities, including saunas, have been provided. The facility grounds also show a changed appearance: flower beds and an orchard have been put in.

Attention toward the employees, genuine, sincere concern with their professional advancement as well as improvement in living and working conditions distinguish the daily activities of enterprise manager Col A. Zhemaytis. Concern for each individual employed at the ARP is always a matter of first importance to him. The employees have faith in the enterprise manager, back him up, and support his useful initiatives. As we know, people like strong, firm leaders, for an important undertaking requires a firm character, firm will and solid ability. Party member Zhemaytis possesses all these qualities. It is for this reason that the results not only of his labor but of the labor of the entire workforce are so substantial.

Recently the enterprise has achieved a 2.7-fold increase in labor productivity, while output volume has increased by a factor of 3.3. These figures have been achieved through an increase in return on capital. Repair and overhaul costs have decreased by a factor of 1.3, while profits have increased 6.3-fold.

They are enjoying a deserved growth in income. Average monthly wages are growing steadily at this enterprise. As of January of this year the workforce shifted over to new

conditions of labor remuneration and new pay rates. The bonus system is continuously being improved. The collective principle of awarding bonuses and distribution of bonuses taking into consideration each person's contribution to the end result is being adopted more extensively.

Four 50-unit apartment buildings and a dormitory as well as a combination kindergarten-nursery school have been built, financed by earned funds, and 51 slots in the new kindergarten-nursery school have been set aside for the children of enterprise employees. The ARP's employees enjoy rest, recreation, and medical care at sanatoria, rest hostels, and at vacation centers. A project to build a recreation facility outside town is in progress.

The employees are responding to improvement in living and working conditions with honest, highly-productive labor. For 15 years now there have been no air mishaps through the fault of the ARP people. The enterprise has been awarded the title "Excellent Workforce." Plant employees are ending up the current year of the five-year plan with good work performance figures.

Today's heightened demands are requiring that the workforce and party organization focus attention on unresolved problems, and there are many of these. They include production automation and mechanization, reducing the percentage share of manual labor, increasing the shift factor, improving product quality, strengthening discipline, and increasing manufacture of consumer goods.

Preparations to adopt full economic accountability and self-financing as of 1 January 1989 as well as entry into force of the USSR Law on the State Enterprise are placing stronger focus on existing problems and are forcing the ARP command element to look several years ahead and to seek in a thoughtful and conscientious manner new approaches to improving production, management, and financial activities.

Colonel Zhemaytis maintains that the party and government policy directed toward increasing production volume primarily through intensive methods as well as accelerating the resolution of social matters requires defining the general goals and devising a strategy: to look in a different manner at construction of facilities and acquisition of new equipment, to analyze in a more substantive manner effectiveness of utilization of equipment-category assets, and on this basis to adjust construction plans and schedules in the direction of shortening the time frame. It is essential to look for ways and means of accomplishing accelerated resolution of social problems pertaining to the workforce. In spite of extensive construction, 180 families are on the waiting list for better housing. There is no recreation center facility, no gymnasium, no shopping or personal services facilities, and no Pioneer camp.

What can be done to accomplish these tasks more rapidly? Analysis of degree of intensiveness of utilization of allocated land sites has indicated that reserve potential is practically exhausted with a single-shift operation. A number of sections are continuing to operate at overloaded capacity. This has made it necessary to form a special team at the enterprise to deal with studying ways, methods, and means to convert the ARP over to two-shift operations.

This changeover is to be accomplished via a parallel track. First of all, work stations in the maintenance shops repairing and overhauling removable equipment are to be integrated into pairs, with subsequent upgrading of one and elimination of the other. Secondly, two-shift operations are to be set up in the airframe maintenance and overhaul shops, and a determination of the resulting effect is to be made.

The people at the enterprise feel that it is very important to avoid methods of management by administrative fiat. It is important to base the changeover of the ARP to a two-shift operation on scientific economic calculations which have received practical validation. It is precisely by means of this that the enterprise has presently succeeded in surmounting a psychological obstacle in the minds of management personnel and a large percentage of the blue-collar and white-collar workers. Even preliminary calculations of the effectiveness of two-shift operations convince one that this is both important and necessary. And people are beginning to understand that they will benefit greatly from two-shift operations. Working conditions as well as availability of services and amenities will improve by the freeing up of floor space, and return on invested capital will increase, as will the economic incentive fund.

The new conditions of economic management have also brought the command element new and difficult tasks. It is no longer sufficient to be merely an executing agency. It is necessary to transform each and every specialist into a genuine proprietor of his enterprise and to induce engineers and production innovators to engage in creative, innovative search. Every engineer submits monthly reports toward this end: the engineer states what he suggests be adopted and where, and what effect he proposes to obtain from this. In order to stimulate collective innovation, every week, at meetings with the enterprise head, each supervisor presents his suggestions on improving work organization. Initiative and new approaches are supported by the command element. A workforce council is active at the enterprise, headed by B. Dargis. B. Savelyev, M. Mayakov, I. Sarychev, Ye. Konovalov, O. Yakovlev, and others are making a large contribution to the common cause. Nor has the workforce ignored organization of new forms of manufacture of consumer goods. Two cooperatives have been established in association with the plant toward this end. Work is in progress on turning out agricultural products

on a contractual basis. Consideration is being given to converting the manufacture of certain product items and provision of services on the basis of a lease contract.

Many problems remain for the ARP manager and work-force to resolve in the course of restructuring their operations. But the workers and management are capable of resolving these problems. The time has come for action, for practical changes.

Problems of Communications Satellite Electromagnetic Compatibility Discussed

91441150n Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 88 (signed to press 4 Nov 88) p 39

[Article, published under the heading "Problems of Astronautics," by V. Lyapunov: "Electromagnetic Compatibility of Satellite Systems"]

[Text] The world's first artificial Earth satellite, launched from the Soviet Union on 4 October 1957, not only signaled the beginning of the era of man's conquest of space but also resulted in the establishment of a number of systems and organizations for radio-frequency communications, television, weather services, and investigation of Earth and space. Broadening of the domain of employment of electronic equipment and increase in equipment quantity and power in turn have resulted in a gradual saturation of the radio-frequency bands with electromagnetic fields of man-made origin and have generated the problem of electromagnetic compatibility, that is, the capability of electronic equipment to function normally under actual operational conditions.

In the early stages this problem was not as acute as it is today, since operating frequencies could be selected in uncluttered areas of the radio-frequency band. In addition there was a possibility of geographic spacing and separation of electronic facilities, utilization of new areas of the radio-frequency band, and improvement of individual parameters of radio-frequency emissions and receiving by increasing their efficiency.

Subsequently, as the radio-frequency band became saturated, ensuring electromagnetic compatibility became a serious problem affecting many areas of radio engineering. From a technical problem it became a socioeconomic problem and took on a global character.

This is why radio-frequency bands are distributed among radio broadcast and communications organizations at World Radio Communications Administrative Conferences (VAKR). The last such conference was held in 1979, and the preceding one in 1959. The table of frequency allocations among radio services has become one of the most important components of the International Radio Communications Regulations.

Future allocation of frequency bands among all radio services is the first and highest level of resolution of this problem. A key to the effective utilization of the radio-frequency spectrum is sought precisely at this stage: boundaries of frequency bands allocated to each radio service are established, as well as radio service status, and conditions of compatibility, including basic standards for radio emissions parameters.

General operational rules and procedures within a radio service are determined at the second level, radio frequency allocation plans are drawn up, and requirements on emission and receiving parameters are refined and detailed, including standardization, and authorization is issued for the development and commercial manufacture of equipment.

These can be called strategic levels, since the most general problems are addressed here. But a third level encompasses a broad range of specific problems pertaining to electromagnetic compatibility, which as a rule are local in nature. They include design, development and manufacture of electronic equipment, design and organization of operation of radio communications links and nets, and securement of so-called intrafacility electromagnetic compatibility (on board a telemetry monitoring ship, aircraft, or on a space vehicle).

The problem of electromagnetic compatibility is most acute as regards satellite communications systems, which employ a geosynchronous orbit. We shall discuss some of the aspects involved.

First of all we shall note the unquestioned advantages of geosynchronous satellites. Around-the-clock communications can be conducted via such satellites. Automatic satellite tracking systems are considerably simplified or even eliminated at ground stations, since stability of satellite signal level is fairly high due to the constant distance, while there is little or no frequency shift caused by the Doppler effect. A geosynchronous satellite's line-of-sight coverage encompasses approximately one third of the Earth's surface. A system of three such satellites provides virtually global communications.

It is these advantages which have led to the intensive utilization of geosynchronous orbits. The geosynchronous orbit zone is presently almost saturated to the maximum with communications satellites. Nevetheless an additional approximately 200 satellites are to be placed into geosynchronous orbit within the next six years.

Do these plans not threaten geosynchronous-orbit overcrowding? There is no danger from the standpoint of probability of collision between and mutual shadowing of satellites. The geosynchronous orbit zone stretches a fairly large distance—260,000 km, while satellites are not more than a few meters in size. In addition they are to a certain degree scattered in altitude, velocity, and inclination.

But if we examine this problem from the standpoint of electromagnetic compatibility, we see that the geosynchronous orbit zone is already overloaded in certain areas in certain frequency bands. Satellites are positioned in orbit with a spacing of 3-4 degrees in order to avoid mutual interference with the present selectivity of antennas operating in a common frequency band. Only in rare instances is the angular distance between them reduced to 2 degrees. Thus it is possible to place in geosynchronous orbit not more than 100-180 satellites operating in a common frequency band. Separation of satellites by frequency is difficult for some services because, for example, their satellite repeater generally uses a large part of their allocated frequency band in one or even in both wavebands, while organization of communications in other, higher-frequency bands allocated to the given service involves certain difficulties connected with power requirements and technical aspects.

How can this problem be solved?

In connection with this situation a number of countries (particularly developing countries) have expressed the desire for geosynchronous orbit allocation on a planned basis, assigning each country an orbital position and a band of frequencies for servicing a specified zone. Such a plan was drawn up for the radio broadcasting services of the countries in the Eastern Hemisphere and was adopted at the 1977 VAKR. It was adopted for the Western Hemisphere at a Regional Administrative Radio Communications Conference in 1983.

The question of utilization of the geosynchronous orbital zone for scientific and technological research with the aid of satellites was addressed at the first session of the 1985 VAKR. Once again a number of countries proposed equal access to geosynchronous orbit. It was decided at this session that a so-called allocations schedule should be drawn up for national satellite systems, a schedule which would meet the needs of all countries. This plan prescribed allocation of 800-megahertz subbands within the 4-6 and 11-14 gigahertz bands for "space-Earth" and "Earth-space" links. All unresolved items were brought up for discussion at the VAKR.

In addition to organizational measures, certain technical studies are required in order to resolve this problem. As a rule interference from adjacent satellites and ground communications facilities operating in the same frequency band is added to the useful signal. For this reason additional technical solutions to increase the spatial selectivity of ground station and orbital vehicle antennas, to maintain a satellite in a stable position in orbit, to accomplish precise training of ground station and space vehicle antennas, to accomplish effective signal separation and polarization decoupling, to employ methods of interference-resistant coding, signal processing by the satellite, employment of new, higher-frequency bands, etc are needed in order to ensure electromagnetic compatibility of satellite communications systems.

Thus the future prospects for utilization of geosynchronous satellites depend entirely on the development of technical means and improvement of the procedure of allocation of positions and frequency bands for geosynchronous satellites.

Long-Term Mars Exploration Plans Outlined

91441150o Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 88 (signed to press 4 Nov 88) pp 40-41

[Article, published under the heading "Readers Request," by Yu. Zaytsev, department head, USSR Academy of Sciences Institute for Space Research: "Mars After Phobos"]

[Text] **Our readers have asked the editors to discuss Soviet space exploration projects in greater detail, and Mars missions in particular. The article below discusses the basic aspects of the stage-by-stage investigation of this planet.**

One important focal area of the extensive program of scientific investigation employing the Phobos unmanned probes will be the search for areas on the planet Mars which are most preferable for the landing of future manned expeditions. Preparation for and conduct of such expeditions will be the main thrust of the Soviet program of exploration of the solar system up to the year 2015.

At a Moscow forum held in October 1987 on the occasion of the 30th anniversary of launching of the first artificial Earth satellite, Soviet scientists presented for discussion by the international scientific community a long-range program for the exploration and investigation of Mars and offered participation by others in this program.

It is planned to carry out the program in several stages. The first stage is scheduled to begin in 1994 with the launch of two interplanetary robot vehicles, each of which would include an orbital module for remote-sensing investigations; a descent module, carrying a balloon station and a Mars rover vehicle; a dispenser carrying 10 small meteorological beacons and devices for landing them on the surface; soil penetrator probes dropped onto the plant's surface to investigate the physicochemical properties of the soil. During the mission a small subsatellite will be separated from the orbital vehicle, tasked with obtaining data for constructing a model of the Martian gravitational field. It is planned to carry out scientific investigations with the aid of precision trajectory measurements of the "Orbital Vehicle-Subsatellite" system.

The principal task of the orbital vehicle is a general and a detailed survey of the planetary surface. The possibility of returning photographs from Martian orbit to Earth is also being considered.

The scientific equipment array will also include an onboard infrared radiometer, a long-wave radar, gamma spectrometer, magnetometer, and a plasma unit.

Aerostat-based sensing can be performed by a balloon which would fly only during the day, descending onto the planet's surface at night. It would consist of two connected balloons—a large lower unit, consisting of an open plastic gasbag containing Martian "air," and a small, sealed upper unit of Mylar film, filled with hydrogen or helium. The lower balloon unit would be designed so that it would produce lift only during daylight hours, under the effect of heating of its gas mixture by the sun's rays. Employment of this principle in designing the aerostat will make it possible to ensure that the scientific instrumentation-carrying gondola will travel a considerable distance from the descent vehicle landing site. Existing data on the dynamics of the Martian atmosphere enable us to calculate possible aerostat flight paths and to select those which would present the greatest interest.

A no less difficult technical problem is that of controlling the Mars rover vehicle, if one considers the complexity of conducting communications at a distance of millions of kilometers. For example, the Mars rover should have the ability to go around obstacles which as recently as 20-30 minutes previously had not yet been in its path. Radio signals will require approximately this much time to travel from Mars to Earth and back. One solution to the problem would be to make the Mars rover an expert system, giving it certain "intellectual" capabilities. In this case Earth would determine operation strategy, while the robot itself would determine tactics of execution.

In addition to a TV system, it will evidently be necessary to equip the Mars rover with a laser rangefinder device for course plotting, vehicle steering and control.

The Mars rover's navigational equipment must perform two principal tasks: navigation to specific preselected areas, and route coordinate survey and tie-in.

It is planned to perform independently tie-in of the landing site and the Mars rover route of travel to the terrain: on the basis of route track calculation data, astronomical observations (Sun, stars), and with a special system incorporating equipment to raise video cameras to a height ranging from several tens of meters to hundreds of meters above the Martian surface. This system will provide capability to inspect an area 100 meters square, with a resolution of better than 1 meter, which will make it possible to perform a highly-accurate tie-in of the Mars rover's position to a high-accuracy photomosaic-derived photomap of the Martian surface.

It is planned to use three different means of raising the video cameras: aerostat (balloon), aerodynamic (kite), and ballistic. The latter means is viewed as a backup.

The Mars rover should have a range of several hundred kilometers. Its speed will be determined by its propulsion unit and will depend on topography and the scientific program to be carried out en route. Either solar panels or isotope thermoelectric generators can be used as power supply.

There is to be a very extensive program of scientific investigation for the Mars rovers, including seismic scanning of areas deep below the planetary surface, in order to determine the planet's interior structure. The Mars rover will also provide capability to obtain a large number of panoramic photographs along its route. It will also provide capability to collect rock samples from a large area of the Martian surface and to a depth of several meters. Collection of deep soil samples is particularly important from the standpoint of subsequent biological analysis. Later the Mars rover could serve as a radio beacon in a selected landing area for a future landing vehicle fitted with a propulsion rocket to return Martian soil to Earth. The Mars rover will also carry meteorological instrumentation.

We should state that study of meteorological conditions on Mars is an important task in the first stage of planned investigation of this planet. It is also planned to deploy a network of 10 small long-lived (more than one year) meteorological beacons on the Martian surface for the same purpose. Their main function will be direct measurement of meteorological parameters in order to study the general circulation of the atmosphere and to forecast weather conditions for the current and future missions. The advantages of such a network include large coverage area and the capability to drop sensors into particularly interesting areas (canyons, ancient riverbeds) which are not easily accessible to investion by other means.

The soil penetrators, in addition to studying the physicochemical properties of the planet's soil, will enable us to obtain data on the planet's internal structure. Several penetrators will form a network of fixed-site stations providing extended seismic observations.

The following stage of the Soviet Mars investigation program will also be characterized by no less innovation and complexity. Its main objective is to deliver specimens of Martian soil to Earth. The timetable for this will be one of the closest "astronomical windows" after 1994. As we know, it is best to send manned and unmanned vehicles to Mars (from the standpoint of boosting sufficiently large payloads into a Mars trajectory) when it is in superior conjunction with Earth, positioned on the opposite side of the Sun.

Such opportunities to accomplish passage between the two planets with minimum energy expenditure and in minimum time (6-8 months) will recur approximately every two years. Consequently delivery of soil from Mars can probably be accomplished in 1996 or 1998.

One variation of accomplishing this phase of Mars ivestigation is the launching of two separate vehicles. One would land on the Martian surface, while the other would orbit the planet. The descent vehicle should carry a rocket for launch from the Martian surface as well as a small Mars rover vehicle to collect soil at some distance from the landing site. The Mars rover would be equipped with manipulator arms and a loading device, which will provide capability to take samples from considerable depth.

The booster rocket will carry the soil samples to the orbital vehicle and dock with it, after which the samples would be transferred into a special Earth-returnable module in the second vehicle. Upon approaching Earth it would be intercepted by an orbital space station.

It would be expedient to perform initial analysis of the Martian soil aboard the space station. This would make it possible to resolve the problem of a quarantine eliminating the possibility of contaminating our planet with extraterrestrial organisms, no matter how small the probability.

The next stage in the Mars investigation program could involve the operation of large Mars rover vehicles with a long active life span and a range of more than 1,000 kilometers, to fall within the years 2000 and 2005. Later, in the year 2010, for example, a combined mission could be carried out, landing Mars rover vehicles and collecting soil from two or three sites located a considerable distance from one another. And, finally, by the year 2015 we would evidently have the necessary conditions for a manned expedition to Mars, landing cosmonauts on the Martian surface.

It is planned to use new-generation unmanned vehicles—so-called "high-intellect space robots"—as base system for carrying out the Mars program. Project Phobos has provided the first practical experience in employing such equipment.

We must state that right from the first stage of development of the new vehicle its designers were thinking about future Mars explorations. For this reason they also endeavored to ensure maximum continuity of design of the systems for performing a comprehensive program of experiments.

The thoroughly-proven, highly-reliable Proton rocket is used to launch these vehicles.

The Mars investigation program looks different if the new Energiya launch vehicle is used. With the Energiya a single launch could essentially accomplish all principal program tasks. Preliminary estimates indicate, in particular, that a single Energiya launch vehicle can deliver three rover vehicles to Mars at the same time—one heavy vehicle with deep-boring capability, and two light vehicles, several canisters carrying 10 meteorological beacons each, and a large number of soil penetrators. It will also be possible to remove weight limitations in solving the problems of bringing back soil from Mars and returning photographic film from Mars orbit. An attempt could be made at the same time to bring back soil from the Martian Moon Phobos.

A future Mars program using the Energiya launch vehicle would be as follows. The first stage (1994-1996)—conduct of general investigation of the Martian surface and atmosphere using an array of heavy automatic vehicles and detailed study of interesting areas of the Martian surface by remote sensing from a base station in a close to circular polar orbit (altitude 200-300 km).

This would be followed by investigation of the Martian surface by direct methods, using Mars rover vehicles, a drilling unit, and soil penetrators; study of the atmosphere using balloons and small meteorological probes, and the planet's internal structure utilizing electromagnetic and seismic methods. One of the main tasks of this phase of the investigations would be search for the most interesting site to land a manned expedition and acquisition of information on natural conditions on Mars.

The second stage (2000-2005) would include full-scale rehearsal of the basic elements of a manned expedition. There would be detailed study of individual regions and return of Martian soil samples to Earth. For all practical purposes this will be a dress rehearsal for a manned expedition, but without crew.

For the first time it will be possible to accomplish an interplanetary flight using a nuclear electric rocket-propulsion unit. Its most important feature is a very high gas discharge velocity. The amount of working medium required for an electric rocket-propulsion unit is less than that required by liquid-fuel motors by a factor of 15-20. This means that vehicle payload can be increased.

Finally, the third stage (2005-2010)—a manned expedition to Mars.

From a technical standpoint a manned mission to Mars is a rather complicated affair at the present time, but it is an entirely realistic undertaking. But the problem of ensuring crew radiation safety is more difficult than for Earth orbital missions, and therefore a special radiation shelter would be provided aboard a Mars ship. Equally unresolved is the problem of maintaining continuous, reliable communications with the crew. In addition to the fact that it takes a long time for a radio signal to travel the great distances from Earth to the spacecraft,

there is another difficulty—disruption of radio communications when the spacecraft drops behind the Sun. It is therefore important to provide maximum spacecraft self-sufficiency and independence of crew actions.

Scientific organizations and specialists from many countries, including the United States, have displayed interest in taking part in the Mars program proposed by Soviet scientists. In particular, the possibility of joint activities by Soviet space vehicles and the U.S. Mars Observer vehicle in 1994 is being worked on. The U.S. vehicle, for example, could receive telemetry data from the Soviet balloons and Mars rovers. No less important is organization of a joint ground network for around-the-clock receiving of data from Mars orbital vehicles. Coordination of investigation of individual regions of the planet is also of particular interest.

There is also a possibility of placing a joint Soviet-U.S. space vehicle into orbit around Mars or of landing it on the Martian surface. Improvement of the political climate in the West is creating conditions for such cooperation in space.

U.S. Satellite Early Warning System Described

91441150p Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 88 (signed to press 4 Nov 88) pp 42-43

[Article, published under the heading "The Pentagon's Orbital Arsenal," by Col A. Radov: "Space-Based Early Warning System"; based on materials published in the foreign press]

[Text] U.S. military and political leaders have constantly sought and continue to seek to achieve military superiority over the USSR. They have been pushing the arms race for decades, justifying their actions with the myth of a "Soviet military threat." Our country has been forced to take measures to assure its security.

When the Soviet Union acquired nuclear missile weapons, the United States lost its position as an "impregnable fortress," but this did not fit within the U.S. "strategy of massive retaliation," which prescribed fighting a war far from the continental United States, based on nuclear superiority. There began a persistent search for ways to protect U.S. soil from a retaliatory strike. The problem of early warning of ballistic missile launch was placed on the agenda.

For all practical purposes the United States began efforts to develop means of detection in the mid-1950's. The first result achieved in these efforts was the ground-based BMEWS system, adopted in 1963, consisting of three radar sites (in Alaska, in Greenland, and in Great Britain). After undergoing a number of modifications, it is still operating today. Poor accuracy of prediction of warhead impact areas and inadequate warning time, however, which were noted when the system first became operational, were cause of dissatisfaction on the part of U.S. military and political leaders.

Work on this problem was conducted in two directions: utilization of over-the-horizon radar, and development of specialized space vehicles, on which principal attention was subsequently concentrated.

Work on developing capability to detect ballistic missiles with the aid of orbital vehicles began in the United States in 1960 with the launch of the Midas series satellites. These satellites were boosted by Atlas-Agena launch vehicles into a near-polar orbit ranging between 3,300 and 3,700 km in altitude.

Both highly encouraging (detection of a Titan ICBM 90 seconds after launch at an altitude of 60 km) and negative results were obtained from the first launches. In particular, it was established that in certain orbital vehicle positions relative to direction toward the Sun, in addition to recording the exhaust flares of missiles under launch, the vehicle recorded sun glare reflected from the cloud edges at high altitude. This led to a large number of false alarms. In addition, it was determined that the satellite orientation system was not accurate enough and that the satellite was excessively complex in design.

In connection with this, Midas launches were temporarily suspended in the spring of 1962, and work on this program was redesignated to the rank of research. Orbital studies were resumed in 1963 with the launch of a Midas satellite as well as manned Gemini missions, utilizing ICBM training launches and static tests. Capability to detect not only liquid-fuel (Atlas, Titan) and solid-propellant (Minuteman) ICBMs but also reentry vehicles in the terminal phase was demonstrated. At the same time encouraging results were obtained in the area of development of multielement infrared-band photodetectors, which make it possible to detect and track ballistic missiles by their exhaust flare against the Earth background from geosynchronous orbit.

From 1966 Project 949 continued work in the area of ballistic missile detection by orbital vehicle. The first experimental satellite developed in the course of this project, designated IMEWS-1, was launched in August 1968. The satellite carried, in addition to missile launch detection gear, sensors to record nuclear bursts.

Four satellites of this series were launched by September 1970, to refine the detection equipment (one failed to reach its intended orbit). These satellites produced positive results in monitoring ballistic missile launches and recording nuclear bursts. This provided a basis for making the system provisionally operational.

Operational satellite launches commenced in 1970, and in 1972 a space-based early warning system using the IMEWS satellite was declared fully operational and turned over to the North American Aerospace Defense

Command (NORAD). It was placed on operational alert duty at the end of 1973-beginning of 1974 and deploys 3-4 primary and 2-3 backup satellites positioned over the Indian, Pacific, and Atlantic oceans, providing fairly reliable monitoring of practically all directions of missile approach threat both covering the Eurasian continent and SSBN combat patrol areas.

When a missile launch is detected, data to this effect is transmitted by the satellite to data collection ground stations at Buckley Field, Colorado, and Alice Springs, Australia, and is then transmitted by military satellite communications system channels to the NORAD command center, since 1985 designated the U.S. Air Force Space Command.

IMEWS-1 satellites weigh approximately 1,150 kg. They are 6.5 meters in length and are a maximum of 2.8 meter in diameter. The satellite is stabilized in orbit by turning on its longitudinal axis (5-7 rpm), which ensures scan coverage of the targeted surveillance area. The bulk of the onboard equipment is contained in a cylindrical shell. An IR sensor (a Schmidt infrared telescope) is mounted at the end of the cylindrical shell facing the Earth. Telescope length is 3.6 m, aperture 0.9 m. The telescope axis is displaced approximately 7.5 degrees relative to the satellite's longitudinal axis. There is a photodetector device positioned in the telescope's focal plane, consisting of a two-dimensional lattice containing 2,000 sensitive elements (detectors) of lead sulfide. These elements have a maximum sensitivity at a wavelength of 2.7 microns and operate at a comparatively high temperature (193° K). Each detector has in its field of view an area of the Earth's surface measuring 3.7 x 3.7 km.

Data received on the ground makes it possible to identify the pulse-originating detector and to determine the intensity of infrared emission, the time and frame number from the voltage, converted into digital form. The onboard information processing device logic is designed to reject spurious signals. In addition, multiple recording of emission source during several passes makes it possible to distinguish a moving rocket from a fixed target, to determine its velocity vector, and to predict the reentry vehicle impact area.

The detection instrumentation also includes a visible-light sensor (video camera) to recheck information received from the IR telescope. A nuclear weapons test detection sensor and the antennas for communication with ground stations are located at the point of juncture of the instrument bay and telescope.

TRW Systems has built 13 operational IMEWS-1 series satellites under contract with the U.S. Air Force. The last of these was launched on 28 November 1987.

During almost 15 years of operational service the satellite early warning system has demonstrated a comparatively high degree of reliability of monitoring practically all directions presenting a missile threat to the United States. Capability to detect missile launches 50-90 seconds after launch and capability to deliver information to U.S. Department of Defense officials 3-5 minutes after launch have been confirmed. Missile launch information is received at the NORAD command center 3 minutes after launch. Five minutes after a missile is launched, its flight trajectory parameters are computed and the degree of threat to the United States is determined.

In the estimate of U.S. experts, warning of a land-launched missile strike is received approximately 30 minutes before warhead impact, while warning of sea-launched missile strikes is received 6-8 minutes before impact, depending on the patrol areas of the launching submarines. In addition, this system provides determination of ballistic missile launch coordinates, preliminary calculation of probable reentry vehicle impact areas, observation of range tests and training missile launches, as well as detection of nuclear tests in the atmosphere.

In spite of fairly good performance characteristics and adequate operational reliability, the satellite ballistic missile early warning system, in the opinion of U.S. Department of Defense experts, has a number of serious weaknesses: a small number of ground stations for receiving data; poor protection of communications links against interference and/or jamming; vulnerability of scanning infrared detectors to nuclear radiation and the effects of radioactive irradiation from nuclear bursts. System equipment has limited capability as a consequence of inadequate IR sensor sensitivity and resolution, which prevents observation of objects across a broad range of contrasts.

This forced the U.S. Air Force to adopt a decision at the beginning of the 1980's to upgrade the satellite early warning system. Principal attention was focused on increasing probability of missile launch detection, accuracy of determination of flight trajectory and prediction of reentry vehicle impact points, and on improving promptness of transmission of missile launch data to top U.S. Government leaders and U.S. Air Force authorities. The number of operational satellites in the system is being increased to four, not counting backups.

Efforts to reduce the vulnerability of the system's ground component included plans to replace two ground receiving stations with a network of small mobile stations receiving information on U.S. soil via communications relay satellite. An experimental simplified ground station was built in 1978. Six mobile stations for receiving special data from IMEWS-1 satellites became operational with the U.S. Air Force by the end of 1985.

Station equipment is housed in standard van trucks and includes communications gear and a data processing subsystem. Communication with these satellites employs a special jam-resistant secure data transmission system

terminal. Since 1987 information received by the mobile stations has been passed on to the space operations command center established at Peterson Air Force Base, Colorado.

Work is simultaneously in progress on upgrading the system's orbital component. Since 1981 TRW Systems has been developing a new-generation satellite under U.S. Air Force contract—the IMEWS-2. It is planned to use the space shuttle, in combination with an orbital transfer vehicle, to place these satellites into orbit. Special attention is being devoted to ensuring satellite survivability in conditions of possible employment of antisatellite weapons and other countermeasures.

In addition, the IMEWS-2 satellites will be equipped with a satellite-satellite link laser communications system, which will make it possible to reduce data loss from interference or intentional jamming, and will also reduce dependence on data receiving stations located outside U.S. soil.

The onboard solar power installation will boast greater output (1,265 watts), by increasing solar panel area on the lower part of the satellite body. The power unit will have a service life of at least 5 years. It has been reported in the foreign press that there are intentions to place a nuclear power installation of about 5 kilowatts on second-generation satellites.

In mid-1987 the U.S. Air Force signed a 750 million dollar contract with TRW systems to build five IMEWS-2 series satellites over a period of six years in addition to the four satellites already on order. Launch of the improved satellite is anticipated at the end of 1988 or beginning of 1989, during the second mission following resumption of space shuttle launches.

U.S. military and political leaders closely link further improvement of the satellite ballistic missile early warning system with progress in the Strategic Defense Initiative program. In addition to warning, the system is being tasked with high-accuracy missile tracking not only during the boost phase but also during the midcourse phase, as well as target discrimination and target designation for interceptor weapons. This radically alters the functional designation of the satellite early warning system in a supporting role and moves it into the category of space-based weapons. The system is to include several dozen satellites in orbits at various altitudes and equipped with IR sensors of various spectral bands. It is claimed that experimental models could appear from the beginning to the mid-1990's.

Thus in spite of positive changes which have been noted in relations between the USSR and the United States, U.S. military leaders have not given up their devotion to plans calling for deployment of promising ABM systems and an extensive program to improve the satellite early warning system.

Index of Articles Appearing in AVIATSIYA I KOSMONAVTIKA in 1988

91441150q Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 88 (signed to press 4 Nov 88) pp 46-47

[Text] **Official Materials, Lead Articles**

70th Anniversary of the USSR Armed Forces

Political and Military Indoctrination

We Are Internationalists

Military-Historical and Military-Political Articles

For a High Degree of Combat Readiness

Into the Military Airman's Arsenal

Aviation Engineer Support of Combat Training and Aspects of Air Forces Rear Services

Flight Safety

Young Officers: Problems of Development

Military Educational Institution Affairs

The Space Program and the Economy

Science Serving the Homeland, Daily Life, Leisure, Health

Years, People, Deeds

Abroad

Critical Review and Bibliography

Articles Not Translated From AVIATSIYA I KOSMONAVTIKA No 12, December 88

91441150r Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 88 (signed to press 4 Nov 88) p 48

[Text]

Publication Data

91441150s Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 88 (signed to press 4 Nov 88)

[Text] English title: AVIATION AND COSMONAUTICS

Russian title: AVIATSIYA I KOSMONAVTIKA

Editor: O. A. Nazarov

Publishing house: Voyenizdat

Place of publication: Moscow

Date of publication: December 1988

Signed to press: 4 November 1988

/10

22161
85

This is a U.S. Government publication. Its contents in no way represent the policies, views, or attitudes of the U.S. Government. Users of this publication may cite FBIS or JPRS provided they do so in a manner clearly identifying them as the secondary source.

Foreign Broadcast Information Service (FBIS) and Joint Publications Research Service (JPRS) publications contain political, economic, military, and sociological news, commentary, and other information, as well as scientific and technical data and reports. All information has been obtained from foreign radio and television broadcasts, news agency transmissions, newspapers, books, and periodicals. Items generally are processed from the first or best available source; it should not be inferred that they have been disseminated only in the medium, in the language, or to the area indicated. Items from foreign language sources are translated; those from English-language sources are transcribed, with personal and place names rendered in accordance with FBIS transliteration style.

Headlines, editorial reports, and material enclosed in brackets [] are supplied by FBIS/JPRS. Processing indicators such as [Text] or [Excerpts] in the first line of each item indicate how the information was processed from the original. Unfamiliar names rendered phonetically are enclosed in parentheses. Words or names preceded by a question mark and enclosed in parentheses were not clear from the original source but have been supplied as appropriate to the context. Other unattributed parenthetical notes within the body of an item originate with the source. Times within items are as given by the source. Passages in boldface or italics are as published.

SUBSCRIPTION/PROCUREMENT INFORMATION

The FBIS DAILY REPORT contains current news and information and is published Monday through Friday in eight volumes: China, East Europe, Soviet Union, East Asia, Near East & South Asia, Sub-Saharan Africa, Latin America, and West Europe. Supplements to the DAILY REPORTs may also be available periodically and will be distributed to regular DAILY REPORT subscribers. JPRS publications, which include approximately 50 regional, worldwide, and topical reports, generally contain less time-sensitive information and are published periodically.

Current DAILY REPORTs and JPRS publications are listed in *Government Reports Announcements* issued semimonthly by the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, Virginia 22161 and the *Monthly Catalog of U.S. Government Publications* issued by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

The public may subscribe to either hardcover or microfiche versions of the DAILY REPORTs and JPRS publications through NTIS at the above address or by calling (703) 487-4630. Subscription rates will be provided by NTIS upon request. Subscriptions are available outside the United States from NTIS or appointed foreign dealers. New subscribers should expect a 30-day delay in receipt of the first issue.

U.S. Government offices may obtain subscriptions to the DAILY REPORTs or JPRS publications (hardcover or microfiche) at no charge through their sponsoring organizations. For additional information or assistance, call FBIS, (202) 338-6735,or write to P.O. Box 2604, Washington, D.C. 20013. Department of Defense consumers are required to submit requests through appropriate command validation channels to DIA, RTS-2C, Washington, D.C. 20301. (Telephone: (202) 373-3771, Autovon: 243-3771.)

Back issues or single copies of the DAILY REPORTs and JPRS publications are not available. Both the DAILY REPORTs and the JPRS publications are on file for public reference at the Library of Congress and at many Federal Depository Libraries. Reference copies may also be seen at many public and university libraries throughout the United States.